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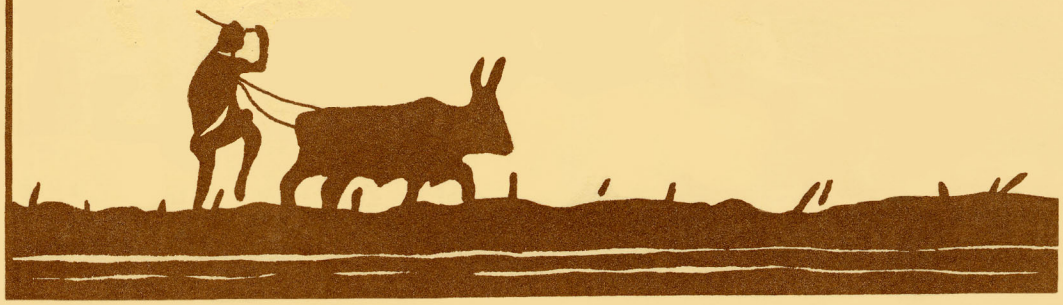
Contributions of FSR/E Towards Sustainable Agricultural Systems

Proceedings of
Farming Systems Research/
Extension Symposium

Paper No. 17 1988

FARMING SYSTEMS RESEARCH

PAPER SERIES



KANSAS STATE UNIVERSITY
MANHATTAN, KANSAS 66506 U.S.A.

Contributions of FSR/E Towards Sustainable Agricultural Systems

Proceedings of
Farming Systems Research/Extension Symposium
1988

Farming Systems Research Paper Series
Paper No. 17

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Winrock International Institute for Agricultural Development

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ACKNOWLEDGMENTS

Special thanks to regional symposium organizers George Axinn, Randy Barker, Constance McCorkle and Jerry Eckert for their assistance and that of their regional organizing committees in the post-peer review of the regional papers. Additional thanks to Robert Hudgens and Donald Voth for their review and editing of the global papers.

Please address any questions and comments to Dr. Tom Westing, Associate Dean/Director, International Agricultural Programs, 300 Hotz Hall, University of Arkansas, Fayetteville, AR 72701, U.S.A.., telephone 501-575-6857, Fax 501-575-5055, telex 314000.

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Beth Barham
Nancy Christman
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Winrock International Institute for Agricultural Development:

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STATEMENT FROM THE SYMPOSIUM HOSTING INSTITUTION

Energized by the recent attention paid to farming-systems research and extension by those concerned with sustainable agricultural systems, the eighth annual Farming Systems Research and Extension Symposium attracted over 312 participants representing 45 countries and provided the forum for over 133 papers. Its impact was felt not only by those who attended but also by the university and local communities.

The symposium also witnessed the development of a broad-based association that actively promotes farming systems research/extension and sustainable agriculture globally. This is a considerable departure from the past, when efforts have been made principally by several universities rather than by a global community of practitioners. This bodes well for the future: as the association garners credibility for the FSR/E concept, funding and other support will become more available to the practitioners of farming systems research and sustainable agriculture.

This association will have increasingly greater impact as people and organizations increase their global interaction: the European Economic community, as an example, is undergoing marked changes in 1992. With the increase in such openness and positive change, the association will increase its mandate to coordinate and promote the practices of farming systems and sustainable agriculture on a broad basis.

We at the University look forward to the 1989 symposium, the theme of which is "Impacts of Farming Systems Research/Extension on Sustainable Agriculture." We also look forward to the association's designation of the next symposium location as well as consideration of possible regional symposia alternating with a global symposium.

It has been our pleasure to host the symposium the past two years and we look forward to our final year as host with the confidence that it, too, will provide a forum for substantive and exciting discussions for FSR/E and sustainable-agriculture practitioners. There have been many consultants, advisors, and participants who have made, and will continue to make, tremendous contributions without monetary reward. We at the University of Arkansas want to thank you for giving freely of your time and applaud you for the excellent product only you could have helped create.

EVENT DESCRIPTION

Sunday, October 9

Time	Room	Session Number	Session
1:00 pm-5:00 pm	CCE 2nd Floor Lobby		Symposium Registration
5:00 pm-6:00 pm			Regional Sessions Coordination Meetings
	CCE 402 CCE 405 CCE 107 CCE 409		Africa Asia Latin America United States
6:00 pm-6:45 pm	CCE 204	1	Opening Remarks and Welcoming to the 1988 Farming Systems Research/Extension Symposium
6:45 pm-9:00 pm	Hilton/ Sequoyah Ballroom		Symposium Opening Reception

Monday, October 10

7:00 am-8:00 am	CCE 2nd Floor Lobby		Continental Breakfast
8:00 am-9:00 am	CCE 204	2	Welcome to the Fayetteville Campus - Or. Daniel Ferritor, Chancellor Keynote Address: "FSR in Evolution: Past and Future" Dr. Michael Collinson Consultative Group on International Agricultural Research/World Bank Introduced by Dr. Hank Fitzhugh, Winrock International Institute for Agricultural Development
9:30 am-10:00 am			Break

CONCURRENT REGIONAL SESSIONS

Concurrent sessions focused on four major regions of the world will occupy the remainder of the afternoon. Break times for each session will be announced by session leaders.

AFRICA

9:30 am-12:00 pm	CCE 402	3	"Lessons from Experience with FSR/E in Africa"
12:00 pm-1:30 pm	open		Lunch

Monday, October 10, cont.

1:30 pm-3:30 pm	CCE 402	4	"Description, Analysis and Implications"
3:30 pm-5:30 pm	CCE 402	5	"Methods and Techniques of Doing FSR/E'

ASIA

9:00 am-11:15 am	CCE 405	6	"Impact Evaluation"
11:15 am-1:15 pm	CCE 405	7	"Farmer Led Experimentation"
1:15 pm-2:30 pm	open		Lunch
2:30 pm-4:45 pm	CCE405	8	"Extension Linkages"

LATIN AMERICA

9:30 am-1200 pm	CCE 107	9	"Methodologies for Assessing FSR/E Projects"
12:00 pm-1:30 pm	open		Lunch
1:30 pm-5:00 pm	CCE 107	10	"Gender and Intra-Household Issues" and "FSR/E Accomplishments in Latin America and the Caribbean"

UNITED STATES

9:00 am-10:15 am	CCE 409	11	"Federal Initiatives" Introduction of Mr. Charles Culver, Legislative Aide to Senator Dale Bumpers, by Dr. Preston La Ferney, vice President for Agriculture
10:15 am-12:00 pm	CCE 409	12	"Domestic FSR/E Accomplishments"
12:00 pm-1:30 pm	open		Lunch
1:30 pm-3:00 pm	CCE 409	13	"Methodologies for Domestic FSR/E"
3:00 pm-4:30 pm	CCE 409	14	"Special Topics"
7:00 pm-9:00 pm	Hilton/ Sequoyah Ballroom		Cash Bar & Buffet FSR/E Steering Committee Report Poster Sessions

Tuesday, October 11

Time	Room	Session Number	Session
7:00 am-8:00 am	Hilton/ Sequoyah Ballroom		Continental Breakfast Informal Breakfast Meeting: Regional FSR/E Networks All Regions Invited. Contact Person: George Axinn
8:00 am-4:30 pm	CCE 2nd Floor Lobby		Symposium Late Registration
8:00 am-9:30 am	CCE 204	15	Regional Sessions Synthesis: Africa Asia Latin America United States
9:30 am-10:15 am	CCE 204	16	Methodologies Keynote Address: "Assessing Institutional Impact of On farm Research Programs: Lessons from a Nine-Country Study" Dr. Deborah Merrill Sands International Service for National Agricultural Research, The Hague, Netherlands Introduced by Dr. Tom Westing International Agricultural Programs, Univ. of Arkansas
10:15 am-10:45 am			Break
10:45 am-11:30 am	CCE204	17	Gender Issues Keynote Address: "Gender Issues in Farming Systems Research and Extension" Dr. Susan Poats, Gender and Agriculture Project, Population Council, New York Introduced by Dr. Richard Harwood, Winrock International Institute for Agricultural Development
11:30 am-12:15 pm	CCE 204	18	Information /Communications Keynote Address: "Back to the Future: The Power of Communications and Information" James W. King and Charles A. Francis, Univ. of Nebraska Introduced by Dr. Richard Harwood, Winrock International Institute for Agricultural Development
12:30 pm-1:45 pm	Hilton/ Sequoyah Ballroom	19	Luncheon Panel Assessment/Inventory Results Presentations Facilitator: Bob Hudgens, Winrock Institute for Agricultural Development

Tuesday, October 11, cont

Panel Members:
Kerry Byrnes, USAID
Billy DeWalt, Univ. of Kentucky
Tim Frankenberger, Univ. of Ariz.
Hal McArthur, Univ. of Hawaii

CONCURRENT GLOBAL SESSIONS

Concurrent global sessions will address the main themes of the Symposium:

- ***o FSR/E Accomplishments in the Field***
- ***o Methodologies for Assessing the Impact of FSR/E***
- ***o Gender and Intra-Household Issues in FSR/E***
- ***o The Role of Information / Communications Systems in FSR/E***
- ***o Special Topics***

2:00 pm-3:30 pm	CCE 402	20	"FSR/E Accomplishments in the Held*
	CCE 404	21	"FSR/E Methodologies: Economic Perspectives"
	CCE 107	22	"Gender and Intra-Household Issues in FSR/E"
	CCE 407	23	"The Role of Information/ Communications Systems in FSR/E"
	CCE 405	24	"Special Topics: Agroforestry"
	CCE 409	25	"Special Topics: Descriptions of Agricultural Production Systems"
3:30 pm-4:00 pm			Break
4:00 pm-5:30 pm	CCE 402	26	"FSR/E Accomplishments in the Field"
	CCE 404	27	"FSR/E Methodologies and Approaches"
	CCE 407	28	"Gender and Intra-Household Issues in FSR/E"
	CCE 409	29	"Special Topics: Natural Resource Management"
	CCE 405	30	"Special Topics: Linkages with Policy Analysis Units in Less Developed Countries
7:00 pm-9:00 pm	Hilton/ Sequoyah Ballroom		Poster Sessions Cash Bar

Wednesday, October 12

Time	Room	Session Number	Session
7:00 am-8:00 am	Hilton/ Sequoyah Ballroom		Continental Breakfast Informal Breakfast Meeting: "Institutionalization of FSR/E" All interested parties invited. Contact person: George Axinn
8:00 am-9:00 am	CCE 204	31	FSR/E Steering Committee Panel Presentation: "Concept Paper for Future FSR/E Activities" Facilitator: Steve Kearl, Univ. of Florida Panel Members: Robert Castro, USAI0 James Chapman, Chemonics, Inc. Michael Collinson, CG1AR Robert Hart, Rodale Institute Rosalie Norem, Iowa State Univ David Norman, Botswana ATIP/ Kansas State Univ.
9:00 am-9:30 am	CCE 204	32	Remarks from Symposium Organizers: Or. Tom Westing
9:30 am-10:00 am			Break

CONCURRENT GLOBAL SESSIONS

10:00 am-11:30 am	CCE 404	33	"FSR/E Methodologies: Recommendation Domains"
	CCE 402	34	"Innovative FSR/E Methodologies"
	CCE 107	35	"Gender and Intra-Household Issues in FSR/E"
	CCE 407	36	"The Role of Information/Communication Systems in FSR/E"
	CCE 409	37	"Special Topics: Research/ Extension Linkages"
	CCE 405	38	"Special Topics: Regional National or Sub-National FSR/E Program Descriptions
11:30 am-1:00 pm	open		Lunch
1:00 pm-2:30 pm	CCE 402	39	"Methodologies for Assessing the Impact of FSR/E"

Wednesday, October 12, cont

	CCE 404	40	"Methodologies for Learning about Gender Roles in FSR/E: A Panel"
	CCE 407	41	Video Presentation and Discussion Session: "Communication Strategies for Inventors and Users of New Technology"
	CCE 405	42	"Special Topics: Regional, National or Sub-National FSR/E Program Descriptions
1:00 pm-2:30 pm	CCE 409	43	Project Sharing Session: University of Arkansas
2:30 pm-3:00 pm			Break

GLOBAL SESSIONS SYNTHESIS

Facilitators for the global sessions will present a synthesis of these sessions by major Symposium themes, summarizing overall comments and policy recommendations for the future.

3:00 pm-5:00 pm	CCE 204	44	Synthesis: "Gender and Intra-Household Issues in FSR/E" Synthesis: Methodologies for Assessing the Impact of FSR/E" Synthesis: "The Role of Information Communications in FSR/E" Synthesis: "Special Topics" Synthesis: "FSR/E Accomplishments in the Field"
7:00 pm-9:00 pm		45	Open Meeting of the FSR/E Network

PRE- AND POST-SYMPOSIUM SHORT-COURSE OFFERINGS

TRAINING FOR TRAINERS
Sponsored by the Gender and Agriculture Project
October 2 - October 7,1988
7:00 p.m. Sunday through 5:00 p.m. Friday
Walker Room, Hilton Hotel

This short course will utilize case study teaching and practice in analysis as a method of assisting agricultural practioners in incorporating gender into on-going agricultural research and extension projects. It will provide a basic foundation and the skills necessary to conduct training programs in-country and other settings on the application of gender analysis to agricultural research and development.
Fee: $650.00

FARMING SYSTEMS RESEARCH METHODOLOGIES: THE NEXT DECADE
October 13-17,1988 8:00am.-5:00 p. m.
Walker Room, Hilton Hotel

A five-day intensive workshop on Farming Systems Research and Extension methodologies will immediately follow the 8th Annual FSR/E Symposium. The course content will be tailored to meet the needs of International Agricultural Practioners, who have some experience in the design, implementation, and analysis to field research. Workshop will emphasize management techniques for integrating crop, livestock, and forestry experiments, operational problems related to inter-institutional linkages, in-service training, gender issues and data management, successful research techniques, as welt as the interplay between FSR methodology and natural resource management concerns.
Fee: $750.00

HEIFER PROJECT INTERNATIONAL LEARNING AND LIVESTOCK CENTER
SMALL FARM PROJECT LEARNING TRAIL
Perryville, Arkansas
October 13,1988 6:00 am. - 7:00 p.m.

The Small Farm Project Learning Trail - a sustainable, small farm – will be available for tour. Tour will highlight a two-acre section of a steep hillside where this productive, diversified farm demonstrates use of livestock in the developing country context, use of solar energy in cooking, brick making, utilizing weeds within the household and farm system, and limited cage aquaculture.
Fee: $65.00

THE MICROCOMPUTER: AGRICULTURAL APPLICATIONS
October 5-9,1988 8:00 a.m. - 7:00 p.m.
Business Administration, University of Arkansas campus

THE MICROCOMPUTER: Agricultural Applications is offered in response to training needs generated by expanded use of microcomputers in the developing country. It is designed for Agricultural Practitioners and Researchers who have responsibility for managing data and conducting statistical analysis. Training emphasis is on the microcomputer operating system, and on the use of a microcomputer to analyze field trial data and survey data This five-days course of intensive training in computer applications provides each participant with individual computer access. Course format includes lecture- demonstration using overhead projection panel, "hands-on" experience four hours per day and open laboratory two hours per day. Training is on MS-DOS, dBASE III Plus, and a comprehensive statistical package.
Fee: $850.00

WORKSHOPS FOR PRESENTERS AND PANEL MODERATORS
Sunday, October 9,1988
Four Sessions: 10:00,11:00 am. & 2:00,3:00 p.m.
Center for Continuing Education

Workshop for Presentators will focus on methods to finalize presentations and plan for effective use of time allocated for presentation. Session one at 11:00 a.m. is repeated at 3:00 p.m. Workshop for Facilitators will focus on specific skills for effectively integrating ideas from the conference sub-themes into open discussion following presentation of papers. First facilitator session at 10:00a.m. is repeated at 2:00 p.m.
Fee: None

GENDER AND AGRICULTURE PROJECT
WOMEN PROFESSIONALS IN AGRICULTURE A DISCUSSION
Thursday, October 13: 8:30 a.m. - 10:30 a.m.
Walker Room, Hilton Hotel

This discussion will provide a forum to examine the issues and of research, training, and programming relative to the subordinate position of women agricultural professionals and the efficiency of agricultural research and development
Fee: None

ENGLISH FOR AGRICULTURE
October 3 - 7,1988 8:00 am. - 5:00 p.m.
Hotz Hall, University of Arkansas campus

This pre-symposium workshop for international agriculture practitioners is designed to improve English - English that is actually used in communicating about agriculture. Workshop will focus on vocabulary of agricultural English, structures of agricultural English, reading and writing in agriculture, giving and understanding oral presentations in agricultural English and editing the agriculture paper.
Fee: $250.00

VIDEOGRAPHY: RESOURCE MANAGEMENT AND PLANNING
October 7-8,1988 and October 14-15,1988
Walker Room, Hilton Hotel

This course will offer in-depth discussion of videography. Videography is the acquisition and interpretation of images obtained with a video camera. It is a powerful tool with wide application to resource and crop management, yield forecasting, stress management, and other disciplines. This course will provide training in utilization of this resource management tool, provide experience with image capture and analysis, and offer farming systems application. Two sessions are offered: A half day session for individuals seeking an overview is available with a two-days session for individuals requiring more information. Sessions are repeated post-symposium.
Fee: 1 /2 day is $75 with 2-days at $260.00

CONTRIBUTIONS OF FARMING SYSTEMS RESEARCH/EXTENSION TOWARDS SUSTAINABLE AGRICULTURAL SYSTEMS IN ARKANSAS
October 9,1988 8:00 a.m. - 5:00 p.m.
Center for Continuing Education

This day long session is planned preceding the 1988 FSR/E Symposium to focus specifically on Arkansas, bringing together those organizations in the state already familiar with farming systems, and seeking out other groups and individuals working on farming systems issues. This program is grant-supported by the Winthrop Rockefeller Foundation, Little Rock, Arkansas.
Fee: $15.00

University of Arkansas Symposium Coordinating Staff

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Nancy Christman
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Dr. Robert Hudgens, Symposium Liaison
Winrock International Institute for Agricultural Development

Program Support Committees

Spedai thanks to the spedai program support committees for gender issues, co-chaired by Hilary Feldstein and Dr. Susan V. Poats, and for information /communications, chaired by Steve Kearl, for their participation in program formulation.

Regional Symposium Organizers

The Symposium Coordinating Staff wishes to express its appreciation to the following Regional Symposium Committees for their assistance in organizing the regional portion of the program.

AFRICA REGIONAL SYMPOSIUM ORGANIZERS

Dr. George Axinn
Michigan State University

Dr. Jim Bingen
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Dr. Russ Freed
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Dr. Delane E Welsch
University of Minnesota

Dr. Woods Thomas
Purdue University

ASIA/NE REGIONAL SYMPOSIUM ORGANIZERS

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Dr. Walter Coward
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Dr. John S. Caldwell
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Consortium for International Development

LATIN AMERICA REGIONAL SYMPOSIUM ORGANIZERS

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Mr. Loren Schulze
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Mr. David Bathrick
United States Agency for International Development

U.S. REGIONAL SYMPOSIUM ORGANIZERS

Dr. Jerry B. Eckert
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Dr. W.R. Schmehl
Colorado State University

David McNeal
Extension Service/U.S. Department of Agriculture

Dr. Michael S. Joshua
Virginia State University

1987 FSR/E Steering Committee

The following individuals were selected as Steering Committee members for the Farming Systems Research/Extension Network during the open Network meeting held at the 1987 FSR/E Symposium.

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The open meeting of the FSR/E Network for the 1988 Symposium is scheduled for 7:00-9:00 pm on Wednesday, October 12.

The University of Arkansas

The University of Arkansas, organized under provisions of the Federal Land-Grant Act, was instituted bythe General Assembly of Arkansas, March 27,1871. Fayetteville was chosen as the site, and the first students were enrolled January 22,1872. The purpose of the Land-Grant Act was to provide a system of public higher education which would offer college opportunities to all qualified persons, regardless of their economic or social status. The University of Arkansas, as a land-grant institution, is committed to this policy. Its basic aim is to provide the finest educational opportunities to ail students, regardless of race, color, or creed.

The Fayetteville campus covers approximately 319 acres and is situated in the Ozark Mountains of Northwest Arkansas at an elevation of 1,400 feet The population of the city of Fayetteville is estimated at 40,000 in 1988, not including the 14,000 students enrolled on the Fayetteville campus for the fall semester of this year.

Four separate institutions are also part of the University of Arkansas System; the University of Arkansas at Little Rock, the University of Arkansas for Medical Sciences (located in Little Rock), the University of Arkansas at Pine Bluff, and the University of Arkansas at Monticello.

The following colleges and schools are part of the University of Arkansas, Fayetteville: the Colleges of Agriculture and Home Economics, Business Administration, Education, and Engineering; the J. William Fulbright College of Arts and Sciences; the Schools of Architecture and Law; the Graduate School; and the Division of Continuing Education. The University's Division of Agriculture includes, in addition to the College of Agriculture and Home Economics, the Agricultural Experiment Station and the Cooperative Extension Service. The College of Business Administration includes the Bureau of Business and Economic Research; the College of Engineering includes the Engineering Experiment Station and the Engineering Extension Center. The Graduate Institute of Technology is located on the Tech Campus in Little Rock.

The University of Arkansas is a member of the North Central Association of Colleges and Secondary Schools.

Winrock International Institute for Agricultural Development

Winrock is a world leader in technical assistance to agriculture. The people of Winrock are making it easier for farmers in the third world and other developing areas to produce more and better food and fiber, thus improving the quality of life for them and their families. Winrock has a long-term commitment to reducing poverty and hunger in the world through sustainable agricultural and rural development. Two basic beliefs guide this work: the importance of developing individual human potential and the need to carefully manage natural resources devoted to agriculture.

Winrock works in partnership with the people of developing areas. Together we strengthen their agricultural research and extension systems, develop their human resources, encourage appropriate food and agricultural policies, manage their renewable resources, and improve their agricultural production systems. It provides research and analysis, graduate education and non-formal training, communication, development assistance, and resource mobilization.

Winrock has more than 225 staff members, half of whom are located at Winrock's headquarters in Arkansas. Nearly 30 are in the office in Washington, D.C., and about 70 are assigned to Winrock projects in 18 other countries.

Winrock was created in July 1985 by merging three respected international organizations rooted in the Rockefeller family's philanthropic tradition: the Agricultural Development Council, the International Agricultural Development Service, and the Winrock International Livestock Research and Training Center. Winrock's activities are funded by grants, contracts, and contributions from public and private sources, and by its endowment As a private, nonprofit institute, Winrock is classified as a 501(c)(3) organization by the International Revenue Service and recognized as a private, voluntary organization by the U.S. Agency for International Development.

ASSOCIATION FOR SUSTAINABLE FARMING SYSTEMS R/E

At the 1988 Farming Systems Research/Extension Symposium, an Ad Hoc Task Force was selected to work on the steps necessary for the formal establishment of an Association for Sustainable Farming Systems R/E. The Task Force has been chaired by George Axinn, formerly of Michigan State University and now working as FAO Representative in New Delhi, India. Committees were established in the following areas deemed essential for the continuity and future growth of the FSR/E Network of scientists and researchers who have participated in one way or another in the Symposium over the years;

- ***o*** Future Symposia Committee (Program and Site)
  Chair: Harold J. McArthur

- ***o*** Editorial Committee
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- ***o*** Finance Committee
  Chair: Robert E. Hudgens

- ***o*** Constitution Drafting Committee
  Chair: Timothy J. Finan

- ***o*** Nominating Committee
  Chair, Donald E. Voth

Reports from each of the committees will be presented in plenary session to those in attendance at the 1989 FSR/E Symposium. A follow-up meeting for questions and answers, amendments and adoption of the committee reports will be held, at which time the formal establishment of the Association is anticipated.

Although formal purposes of the Association will be proposed by the Constitution Drafting Committee, the overall goals of the Association to be discussed will be: to create and maintain an international forum for the exchange of ideas and information on the development of sustainable farming systems; to promote an active international network of teachers, researchers and development agents who share in the interests and objectives of the Association and who contribute to a worldwide understanding of agricultural systems; and to help provide national and international development institutions with a perspective that is sensitive to the sustainability of the local resource base and the needs of the farm household.

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Keynote Address

FSR IN EVOLUTION: PAST AND FUTURE

Michael Collinson[1]

INTRODUCTION

This paper offers a personal perspective out of African experience. It has two parts: the first looks at the evolution of FSR, concluding with factors that have inhibited its adoption as an innovation in research process, and offers a focus for greater effort; the second looks forward to future applications for the process and some possible pitfalls. Both parts reflect an underlying conviction: countries dependent on small farm production for their development need to build the human and institutional capacity to exploit FSR as part of an effective research and development process. This should be the primary goal for FSR addicts.

The paper refers to FSR as a research method for understanding farmers' priorities, strategies and resource allocation decisions. Currently it is most often used in conjunction with on-farm experiments to identify and adapt technology useful to local specific groups of farmers.

THE EVOLUTION OF FSR

FSR - Its Origin as a Response to a Perceived Need

During the 1950s and 1960s, studies began to document obstacles to adoption of technology among small farmers. Many were done in India (see for example Roy et al., 1968) and followed Griliches' (1958) pioneering studies on the adoption of hybrids in the US corn belt. The studies usually focused on the personal characteristics of adopters and non-adopters-education, age, place in the community, etc—and the effectiveness of technology delivery—extension, credit and input supplies. Most of these early studies assumed the technologies promoted were appropriate for small farmer clients.

The 1960s saw a widening interest in the relevance of technology, paralleled by an increasing involvement of economists in agricultural research. From the social science side, it has seemed to me that three developments of the 1960s set the stage for FSR.

1. A questioning of aspects of agricultural research. Australians Davidson and Martin (1965) highlighted the yield gap between experimental plots and fanners' fields and questioned whether experimental method, oriented to returns to land, was appropriate in a country with wide open spaces. There was similar questioning in Africa (Belshaw and Hall, 1970).
2. Farm economists adrift. In Africa expatriate farm management economists, shaken by independence (like agricultural researchers) from their arguably incestuous relationships with large-scale settler farmers, were pondering how to ply their trade with the millions of small farmers in the traditional sector (Hall, 1970; Collinson 1972). Western approaches to farm management advice, dependent on the analysis of farm records and face-to-face discussion with individual farmers, were impractical.
3. Increasing evidence that the socio-economic circumstances of the farm influence farmers' adoption of technology. There was a growing conviction that resource endowments, the management of uncertainty and access to markets were major factors in farmers' motivation, their decisions on resource allocation and their choice of techniques.

In the early 1970s, social scientists came to share the frustrations of agricultural scientists, who saw them as historical commentators on the success or failure of a technology. They began to seek a role in the choice, design and evaluation of experiments.

Through the 1970s other factors helped to create an awareness of the need for relevant technology for small farmers and the need for a new look at research processes. Important factors included the establishment of the International Agricultural Research Centers (IARCs) from the mid-1960s and a heavy emphasis by the World Bank on stronger extension systems, including, later in the 1970s, the need for local, specific, appropriate

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technologies. Development theory embraced a central role for small farmers where they dominate the economy and identified technology as the key to their higher productivity. Lately donors have begun to focus attention on research as a necessary precursor to development. Signs of action are emerging in developing countries, few so far in Africa.

The FSR Contribution to Small Fanner Technology Development

Since FSR appeared in the development vocabulary in the late 1960s, progress has been made. Some of the important FSR-based developments in research orientation and process are listed:

- There is increased client orientation in many national agricultural research services; research is more and more targeted to local specific groups of people operating farming systems rather than to agro-ecological zones, opening channels for sounder linkages with policy formulation.
- There is a growing appreciation that fanners operate systems with limited resources that require compromise on the optimal technical management for any one enterprise.
- There is widening enthusiasm for "pull in" modes of technology generation based on the farmers' perspective, rather than "push out" modes based on the researchers'.
- There is an increasing emphasis on packaging technical components from an understanding of local circumstances and on the importance of sequencing new techniques.
- There is an improving focus of applied research on development constraints defined in the field with farmers.
- Relevancy in applied research is being helped by the recognition that solutions must be shaped by the small farmer circumstances into which they will have to be fitted in order to be acceptable.

A large number of countries, supported by many donors, are wrestling with the implications of these developments for the research process and for research management and organization. Progress, however, has been slow. It is probably fair to say that, of many developing countries that have embraced FSR concepts, none has yet completed the nationwide build up of human and institutional capacity, nor the re-organization of the research process, which the full exploitation of these concepts implies. FSR history underlines the need for the long view and illustrates the complexity of institutional change. Its slow progress reflects many of the inherent problems of underdevelopment and of "north/south" relationships. Some of the inhibiting factors represent important foci for more effective efforts in building national capacity.

Factors Inhibiting the Exploitation of FSR

Professional consensus on an appropriate approach and methods for FSR has been slow. The IARCs may be taken as an example. IITA was set up in 1967, ICRISAT in 1972, ILCA in 1974 and ICARDA in 1977, all featuring Farming Systems in their mandates. The review of FSR in the IARCs by Dillon et al. (1978) came to the conclusion that each had its own version and none was following what the review team considered the most useful approach. It was probably not until the IARC FSR Workshop of 1986 (IARCs, 1987) that the IARCs agreed on a common framework for FSR in the context of technology generation. Even then a "minority report" emerged to supplement the "official" line. (See annex in the FSR Workshop Proceedings.)

As with anything else, a variety of experiences and experiments were essential to the evolution of a robust FSR process. However, the development of the process was confounded with its parallel application in developing countries, and at least three factors exaggerated the effects of this:

- FSR, a process for local specific technology development, and properly a role for the national programs, was a creature of expatriate scientists. It was often perceived by national research service professionals as being imposed from the outside;
- not only was terminology very varied as individuals and institutions tried to put their own stamp on the process (an unending phenomenon), but conversely many different methods were promoted under the same FSR rubric;
- agricultural research establishments were suffering from indigestion trying to swallow social scientists and find useful, uncontroversial things for them to do. Costing the station dairy herd and vegetable garden to decide on the correct price of produce to staff was a favorite backwater.

These factors made the task of introducing FSR into national research processes particularly sensitive. Four or five "outside" groups included these odd "social scientists" peddled their own gospels and disparaged others' efforts.

There is general agreement that national research services are the appropriate location for FSR, and there is wide acceptance by national research managers that small farmers operate complex systems. In east and south Africa, for example, every NARS is involved with FSR at some level. A national structure is in place in Ethiopia, Malawi and Zambia, and other countries have pilot programs and are thinking through the process and organization required for operation nationwide. Despite this, the very fundamental problems of national systems have inhibited their exploitation of FSR as part of the research process.

- Research has low political appeal. Small farm development and publicly funded agricultural research are not clearly linked in political minds, which are often dominated by short-term expediencies.
- With the very weak budget and revenue situations of most developing countries, this lack of appeal penalizes research in competing for government funds.
- Professional rewards and, perhaps more debilitating still, the budgets for research are poor. Talent is lost where alternative opportunities exist; motivation and morale among researchers are low.
- The universities have similar funding, staffing and morale problems that give rise to inappropriate curricula, weak teaching and poor facilities. Emerging professionals are poorly equipped and defensive of their limited expertise and provide weak researcher material.

These four areas offer opportunities to donors to reinforce efforts to strengthen not only FSR but agricultural research and development capability in general. Against this background, however, attempts to introduce a modification of process to traditional research establishments were often overtaken by general erosion of their effectiveness. Training was wasted unless accompanied by budget support and institutional re-organization to implement the FSR process. Training in FSR in east and south Africa began with courses and training materials that emphasized a modification of the classic research process. Trainers found such a weak knowledge of the basics that they were obliged to back up and include teaching of some fundamentals.

Technical assistance from the donors and the International Agricultural Research Centers has given widespread support to the introduction of FSR in east and south Africa, as in other regions. Given the low political appeal of research and the budgetary state in many developing countries, little progress would have been made without it. USAID, IDRC, Ford, CIDA, SIDA, Netherlands, IFAD, ODA, GTZ, FAO, EEC and the World Bank have all funded FSR projects of one sort or another in east and south Africa. USAID alone set up 11 bilateral research projects with FSR as a major component between 1978 and 1985.

The IARCs saw farmer involvement in the research process as essential to the marketing of their research results and to clear signals from the national programs for guiding their research planning. They perceived the need for a long-term commitment to the development of FSR capacity in NARS. However, the commitment of some IARCs to FSR was dictated by their commodity mandates, and their training efforts with the national programs were incidental to a perceived need to diffuse their own technologies to demonstrate progress to donors. These factors sometimes inhibited their ability to look at FSR process development from a NARS perspective, and some of the training offered was peripheral to the real needs of NARS. The same donor pressures encouraged "flag flying" by the IARCs, and there was little incentive for collaborative effort either in process development or in building capacity in national systems.

Much of the donor and technical assistance to FSAR was weak. Project planning and implementation suffered from the faddish, short-term perspectives of some donor agencies and from a lack of FSAR capacity among international development professionals. Early projects provided a learning experience for staff from contracting agencies eager to shift wherever donors placed money. Some American universities used such projects to free up tenure tracks, exposing older professionals to tough field assignments, often their first overseas. Members of interdisciplinary teams sometimes arrived at yearly intervals, in extreme cases just in time to see their team "partners" completing their two-year contracts and going home.

This weak implementation of technical assistance projects in FSR was a third factor adding to client country confusion stemming from the parallel development application of the process. The same weak project implementation, together with the cycle of changing donor interest, particularly by USAID, one of the pioneers of FSR support, has undermined commitment to FSR as the key to "marketwise" research process. This "baby with the bathwater" syndrome has been remarked on many times. It is common to disparage it as serious enough to warrant research on the need for central bureaucrats to popularize development thrusts carrying their personal

stamp-flag flying by yet another group. One also can rationalize it positively as donors acting as a source of ideas. Only support with money will give enough leverage to have poor countries try ideas, witness the spread to T & V extension methods. If they are seen to meet an urgent need, then developing countries will fight to find the money to exploit them.

FSR has been grouped with buzzwords seen as having had their day: integrated rural development, community development and basic needs spring to mind. In some quarters it is seen as superseded by newer ones of participation and sustainability. In truth all these ideas are important; each represents an umbrella for a wealth of concepts. As a look at its evolution has illustrated, FSR is somehow different; it is a response to a very specific, substantive and widely perceived need for technology appropriate to resource-poor farmers.

LOOKING FORWARD: THE FUTURE FOR FSR

FSR, in addition to front ending a systems-oriented farm research process, provides a grass-roots information source with many potential applications. It is being swept up in a widening range of applications and increasingly seen as a vehicle to serve a number of causes. It can improve program planning and policy formulation. It can contribute to reaching the poorest of the poor, to mobilizing women, to enhancing the participation of people in their development and to managing sustainability.

In this forward-looking part of the presentation, I discuss the opportunities and issues in some of these areas in the context of two key interfaces where I see important roles for FSR: one between the farmer and the researcher and the other between farm-level technology and regional- and national-level policy and planning.

I will focus first on what I see as a key issue for both these interfaces: the targeting of research.

Targeting research

Targeting is important to a client-oriented research and development process, in priority setting and for program planning and implementation. A meticulous research process with the wrong target group is history that ought not to be repeated. At present the confounding of three linked perspectives on targeting compromises the place of FSR within the research and development process.

- Agro-ecological and agro-climatic zones used by agricultural scientists, and particularly by breeders, identify geographically discrete areas with the same crop potential.
- A group of farmers operating the same system for whom a discrete technology development and dissemination program might be justified.
- A group justifying priority attention by government agencies: women-headed households or young heads of households vulnerable to urban migration are both plausible examples of policy-designated targets.

This third perspective continually challenged me while working with national governments, promoting and building capacity to use a systems-based adaptive research process. Selfishly, perhaps, I fought to keep a distinction between the process and the causes it can undoubtedly help, which many of my development professional friends urged me to espouse and link into my sales pitch.

In fact, I see the second (farm system) and third ("cause") perspectives as compatible, at least within the farming population. Farmer groups designated by policy as disadvantaged will reflect this in many characteristics of their farming system: lower resource endowments, less area cultivated, a higher proportion devoted to subsistence, lower animal numbers, etc This link accepted, stratifying farmers on the basis of the system they operate is consistent with the identification of those target groups that policy gives priority in research and development. A planning framework of homogenous farming systems serves both the research/farmer and the technology/policy interfaces.

We should be mindful that this leaves aside the challenge of improving consumer incomes now seen as the proper concern of technology choice in agriculture. The focus here is a technology development process that increases the likelihood of farmer adoption—still a necessary intermediate step towards these wider objectives.

There is real confusion, however, between the first two perspectives. The recent decision by the IARCs to concentrate on zoning by physical factors and to leave aside the socio-economic dimensions, described as too changeable, ignores the urgent need for wider guidance on the targeting issue (Bunting, 1987).

In conventional applied research, agro-climatic and agro-ecological zones play three roles:

- they identify, for breeders, sets of conditions with common climatic constraints within which they must work;
- they identify relatively homogenous sets of climate and soil characteristics that can be dealt with by one applied research effort in natural resource management;
- they show where else applied research results will be relevant and facilitate transfer between geographically separate but homogenous sets of conditions.

Agro-ecological zoning has been abused by its use as a general planning tool for research and development. Planners have gone so far as to specify the areas of highest physical potential for a crop as the only areas in which it should be grown and the only areas in which government marketing, input, extension and credit services will promote its development The argument over maize and sorghum in semiarid parts of Africa has sometimes reached this level of absurdity.

It helps to see agro-ecological zones as offering a set of cropping opportunities to farmers-maize, cotton, beans, vegetables, etc-and, at the same time, as a subset of opportunities for each crop. Each crop sub-set is bounded by climatic constraints important to breeders of that crop. For example, possible maturity periods for maize may range even wider than 90 - 250 days, bounded at the lower end by temperature and at the upper end by the limited rainfall period or by frost incidence.

Farmers' choices in the cropping opportunities set, and within the subsets of opportunities for each crop, are determined by their socio-economic circumstances: access to markets, family food preferences, yield and price uncertainties, and endowments of labor, cash and land and government policy. Their decisions in the face of these physical opportunities and socio-economic circumstances are manifest in their farming system.

An aside is necessary to make a point critical of conventional applied research—the pre occupation of plant breeding with expanding yield potential and the pre-occupation of crop management research with demonstrating and exploiting this expanded potential These two strategies keep applied research efforts focused on raising the upper boundary of the opportunity set for each crop. Applied research pays no attention to opportunities inside the set that will often be the right choice for farmers. For example, in an area constrained for maize production by a six-month rainfall period, a 130-day maize variety will offer the highest yield potential and will be the "logical" choice for conventional breeding and selection efforts. The socio-economic circumstances of local farmers may dictate other choices:

- low power resources may prevent farmers opening land until the ground is wet. Earliest possible planting may be 20 days after the start of the rains, suggesting a 160-day variety;
- prices in the local markets may be 300-400% higher five or six weeks before the main harvest, suggesting a 145- to 155-day variety to exploit them;
- farmers may give priority to planting another crop first or to planting a crop in the same land after the maize, suggesting a variety of perhaps 140 days or less, depending on the complementary crop.

Conventional research will fail to offer options to farmers in these sub-optimal areas of the crop opportunity set. Equally important, varieties and practices identified as expanding the upper bound of the set will often be irrelevant to these systems-generated needs.

The truth is that any ranking of crops based on physical potential in an area can be stood on its head-completely reversed—when the socioeconomic circumstances underlying the delicate decisions of local farmers are used in ranking. There remains a real battle to remove physical resources, and the agro-climatic or agro-ecological zones that demarcate them, from general use and abuse. For research and development planning and for policy formulation, the focus must be on people.

Such a focus is an integral part of FSR in the adaptive stage of the research process where it ensures congruity between farmers' and researchers' perspectives. Moreover, as the publications of my colleagues at CIP exhort, when we look at the research process in "farmer back to farmer" terms, this adaptive stage with target groups of farmers identified by farming systems is the start of that circular process. Adaptive research, through diagnosis, represents an information base for ranking farmers' problems nationwide. Applied research priorities, when based on these rankings, properly reflect farmers' needs as a function of their socio-economic circumstances. Such a priority-setting mechanism escapes the tyranny of varieties driven by the search for maximum yield potential.

The appropriate role for agro-climatic and agro-ecological zones is the secondary one of rationalizing applied research programs. We need recognition that results from lower potential zones will be relevant to many farmers in higher potential zones whose current socio-economic circumstances preclude full exploitation of the natural potential of their own zone. Such recognition will bring research to bear on fanners' production options within each crop opportunity set. Following this principle, agro-ecological zoning will facilitate the wider transfer of technology not only between homogenous zones but between zones with overlap in their opportunity sets.

The Farmer/Research Interface

I want to just touch on the issue of participation at this interface. I have more to say on the interface between farm technology and national policy.

Participation

There is widening acceptance in national research services that the extension hierarchy is not an effective channel for the understanding of farmers' problems and that researchers need direct contact with farmers. The FSR approach to adaptive research forms a framework for this contact and for mobilizing its results.

While the concept of participation by the clients in the development process is an old one, it has found limited acceptance in official, government-led initiatives. Within the last few years, it has been promoted for an enhanced role in adaptive research in agriculture. Anthropologists and sociologists, often already involved in FSR, have highlighted the potential contribution of increased client participation to systems-based adaptive research process. One example is in the evaluation of results. Formal economic analysis has great difficulty in weighing the multiple criteria, especially non-market criteria, which farmers bring to bear on decisions. Farmer participation reduces the need to try to second guess such decisions. Participation brings the farmers' perspective to bear more effectively within the process.

The emotive connotations of participation have led some development professionals to see direct farmer participation as a substitute for FSR. However, the need for researchers to understand the farming system clearly remains.

- Many examples have been given of problems that farmers perceive as a way of life, such as mosaic on cassava and scarcity of power at cultivation time. Experience suggests that in the early stages of an adaptive research program, while confidence is being built between scientists and farmers, it is important to work on problems perceived as problems by farmers. Once confidence is established, emphasis can shift to unperceived problems where these are clear priorities for systems development and solutions seem feasible.
- Scientists have to decide which technical research findings are relevant to the problems identified. They have to select those that will be discussed with farmers as possible solutions for subsequent experimental work. Their choice is focused by their understanding of the system and the constraints it imposes on solution options.

The best approach to adaptive research is in partnership. Both farmers and scientists, including social scientists, have knowledge and skills to offer. Discussion will continue about how the partnership should operate, whether in the context of a formal national research process, through the indigenous research process traditionally followed in local farming communities, or by some marriage of the two.

The Farm Technology/National Policy Interface

Awareness of the real importance of the link between farm technology and government policy has grown only recently. Traditionally, national priorities have targeted publicly funded research and development efforts. The failure to reconcile national needs with farmers' needs in this targeting process has resulted in weak programs. Similarly, policy formulation based on perceived national and political needs has often, as in the case of cheap food for urban dwellers, distorted farmers' choices of enterprises and production techniques.

The aim is synergy from technologies tailored to farmers' needs that are mobilized by policies exploiting comparative advantage. Important to achieving it is a policy and planning process that reconciles farmer and national priorities.

Target Groups: The Policy and Planning Interface

The FSR process works best within target groups defined by the homogeneity of their farming system. Just as the technology requirements of these systems may be unique, so the impacts of current or proposed policies also may be unique. The target group is a good interface between technology and policy.

FSR in the context of adaptive research screens potentially productive technologies in the light of national and regional policies. Equally important is the evaluation of current and desirable policies in the light of the technological opportunities of farmers. FSR generates the information required for this, the other side of the same coin. With this interface, institutionalized initiatives on programs can be generated locally and screened against regional and national policy criteria. In FSR the extensive description of farmers' circumstances needed to understand farmers' strategies and decisions on resource allocation includes markets, prices, market access and input and credit availability. Thus the process also identifies weaknesses in local institutions and infrastructure that need improvement to effectively mobilize technology for local farmers. Intimate knowledge of the technologies emerging from adaptive experimentation highlights the types of institutional improvement, as well as the areas of policy development, that will be crucial to programming for a specific target group.

There is a need to demonstrate the use of the information stream created by FSR for both policy formulation and program planning both to raise awareness of the potential from the linkage and to consolidate a process for this important application of FSR. The strengths of such a decentralized, people-centered and technology-based approach to program planning and policy formulation deserve greater attention.

Among the IARCs, CIMMYT is shifting resources into what it terms Farm-based Policy Analysis (FPA).

> FPA sees policy as a variable and builds a case for modifying policy constraints by applying micro-economic tools to farm-level data obtained through OFR programs. [It stresses the need to]... effectively communicate that information to relevant policy-makers to improve the basis for formulating or implementing policy (Yates et al., 1988).

My own bias is that this is a logical extension for the IARCs because of their expertise in systems-based adaptive research. I believe their social scientists should focus strongly in this area, which I see having great potential for the developing countries. Currently several IARCs are moving social science input into commodity analysis and other research areas that, while clearly important to center policy, are not clearly within the comparative advantage of agricultural research institutes and can readily be brought in from the outside.

Sustainability

The most recent buzzword is sustainability. Like its predecessors, including FSR, it is important. Again, like its predecessors, its newness brings confusion. Further, like its fellow traveler, *participation*, it raises strong emotions, particularly where its agenda runs congruent with that of the environmentalists and their strong political lobby.

Leaving aside the global environmental issues such as the ozone layer and ocean pollution, the sustainability of natural resources is clearly a responsibility of the agricultural research and development process. It seems to have two dimensions:

- current geographically specific disaster areas: Amazon de-afforestation, Sahara encroachment, groundwater contamination in the mid-west of the USA and many others;
- widespread, insidious degradation of soils and vegetation due to the pressure of increasing population densities outrunning the evolution of traditional management practice.

The first category of problems in most cases requires strong political and policy support for success. Many of these current, specific disaster areas demand their own special programs, including research, to turn them around.

The second category is perhaps best seen as a problem of weak national research and extension services in developing countries. Given the extent of this general degradation, it cannot be managed by special programs. The coverage required will be achieved only by building up the capacity of national research and extension institutions, by the use of a research and development process that explicitly addresses the longer-term resource management issues and by closer attention to the long-term implications of new technologies.

Surely technologies emerging from agricultural research are rarely (ever?) inherently degrading. The question whether a technology degrades or sustains natural resources arises from the local specific circum-

stances in which it is used. A sustainability perspective is needed in pre-evaluating new technology for a target group of farmers. It can readily be included in the prescreening stage of the adaptive research process. It demands an understanding of local circumstances, including climate, soil and traditional resource management, and of both the short- and the long-term implications of the technology. For example, the prospect of adaptive experiments on the use of nitrogen should lead to an examination in available knowledge of the long-term impact of the different sources of nitrogen on local soils and groundwater, percolation, the evolving demands on other soil elements, acidification, etc. To permit such sustainability evaluations, applied research would take responsibility for documenting the long-term implications of major inputs, mechanical, chemical and biological, for the major agro-ecological zones of the country.

One aspect of the sustainability and indeed the wider environmental issue is worrisome. There is a danger that the growing anxiety about the abuse of natural resources will lead to advocacy for restricting the opportunities available to poor people. Small farmers have no capital or assets in the sense of savings, farm buildings and machinery. Land is their only asset, and traditionally they have exploited it in order to lift themselves above subsistence. Land has been used like savings, invested in the production process to create income streams to give a better standard of living and, in the fortunate situations, to restore the value of the original asset, the land. Population pressure has jeopardized this cycle. The way through is to extend the options available for small farmers to manage their environment

However, there is a squeeze on donor governments from environmentalists on the one hand and heavy lobbies from domestic agriculture and industry on the other. The danger is that the squeeze causes a "do as we say not as we do" reaction in terms of aid and that conditions on agricultural programs begin to restrict the options available to resource-poor farmers for the "bootstrap" process of self development. We cannot condemn others to only 10% of the commercial energy we ourselves feel comfortable with; the high-livers must show the way and allow small developing farmers all the tricks we ourselves used to reach acceptable standards of living. One of the most hopeful aspects of resurgence of the organic fanning school is the spin off in new options to developing country farmers. It would be tragic if environmental pressure resulted in these being perceived as a substitute for, rather than an addition to, chemical and mechanical options. Small farmers will need the full inventory of available technologies to pull through.

CONCLUSION

The usefulness of the FSR process in a wide variety of important areas in small farmer development is at once a triumph and a danger. We have to keep our heads to retain the credibility of the process, which is already under fire. We need to distinguish efforts in three areas:

- to improve and develop the process;
- to replace the process or rename parts as a flag flying exercise;
- to apply and modify the process for new objectives.

Folding FSR into existing research, development, policy formulation and program planning processes seems to be the best way forward. In this we must prevent its potential for a variety of contributions from confounding specific applications of the process. Each initiator must know where his/her application is going and ensure that the focus and the quality of the output is not diluted from the compromises necessary to take on board other interests. We used to say in farm survey work, satisfy as many secondary user interests as you can without distorting your data collection plan. The primary need is to get an effective technology development process in place and human resources equipped with the skills to operate it. Then use its versatility to tackle policy issues and to espouse causes.

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Contributed Papers

African Regional Papers

AFRICA SESSION SYNTHESIS

George H. Axinn

INTRODUCTION

As requested in our program, what follows is a series of generalizations, all of which were synthesized from yesterday's session (October 10, 1988) on Fanning Systems Research and Extension in Africa. There are probably many exceptions to what is written below, but this is an effort to record an observable pattern.

These observations are filtered through my own personal views on farming systems research and extension. These include the assumption that it ought to deal with the farm as a whole system, including many specialized components, but focusing on the linkages that make the components into a system.

Also, they include my assumption that farmers have been doing that kind of research for thousands of years. It is only the specialized training of Western science that has blinded professional agriculturalists to the interrelations among the components of the farming system.

The excitement from yesterday's reading of papers and the lively discussion that followed them was the participation of so many bright, young, vigorous scholars—from many different countries—who are deeply involved in farming systems research and extension. I think that is great.

Now, here are nine synthetic thoughts, issues or problems that emerged from" yesterday's session on Africa:

ISSUES

The Issues of Training

Several of the reports and much of the discussion pointed up the conflict between the disfunctionality of highly specialized advanced post-graduate degrees on the one hand and more problem-centered, generalist preparation for farming systems research and extension on the other hand.

The Issue of Control of FSR/E

If one listened to the papers carefully and asked by whom farming systems research and extension was controlled, I think the response would have to be

By the bureaucracy - yes;
By the scientists - yes;
By farmers - no.

What roles, then, were described for farmers?

Involvement - yes, and growing;
Participation - yes, and growing;
Control - no, not yet.

Gender Sensitivity

Thinking about gender issues while listening to each of the presentations and the discussions during the Africa Session leads to three observations:

- Men dominate FSR/E professional staffs;
- Men dominate field research strategies;
- Women dominate farm work.

Production and Consumption

Assessing the perspective of Farming Systems as producing units or as consuming units was relatively easy. The focus was on production by farmers. There was no mention of consumption by farm families.

Specialization versus Generalization

On the issue of specialization versus generalization in the interrelation of commodities on the farm, there were papers on fisheries and crops; papers on fruit trees and cereal grains; papers on agro forestry, trees or crops.

There were many comparisons, but very few of the scholars could see their own specialization in the context of the larger system.

On-Farm Trials

There was much discussion of on-farm trials and the values of the research station compared with the farmer's field. But there was little attention to the issues of:

- Farmer as a source of free land;
- Farmer as a laborer for field data collection;
- Farmer as informant;

versus

- Farmer as partner in research;
- Farmer's influence on what is studied

Similarly, for Extension Personnel

- Helpers to do research work, or partners with researchers?
- The role of Extensionists as the field eyes and ears of research colleagues-not much.

Technology Versus Systems Analysis

Another comparison was made between technology-driven FSR/E versus systems analysis-driven FSR/E. It was no contest; technology dominates.

Benefits to Extension Staff

First, some Extension staff finally have some technology that is relevant to offer to their clients—some technology that fits the farming systems of the area. That is no small benefit.

Second, they have learned to listen to farmers, even to dialogue with farmers.

And the cost to extension staff is sometimes more hard work, often with no reward from Extension Administration.

Commodity Focus Versus a Farm Family Focus

The commodity dominates FSR/E, even in 1988. After seven earlier annual symposia, the commodities still dominate agricultural research-not only ordinary agricultural research, but even FSR/E.

Well, perhaps that is the challenge of the future. And that is my synthesis of the Africa Regional Session.

INCORPORATING A SOCIOECONOMIC COMPONENT INTO THE MALAWI NATIONAL ADAPTIVE RESEARCH PROGRAM

Thomas E. Gillard-Byers and Grasiano Bulla[1]

INTRODUCTION TO THE MALAWI ADAPTIVE RESEARCH PROGRAM (AN FSR/E HYBRID)

In 1977 in Malawi, the concept of a National Rural Development Program (NRDP) materialized. The purpose of the NRDP is reflected in the following general objectives:

1. To increase the general level of Malawi smallholder agricultural production, in particular the production of cash crops for export and for the country's agro industries, and the production of food crops to maintain self-sufficiency while feeding a growing urban population.
2. To provide the inputs and services necessary to enable smallholder agricultural production to increase with particular emphasis on increasing productivity per unit area.
3. To preserve and maintain natural resources by encouraging high standards of crop husbandry combined with soil conservation. To conserve the key watershed areas and maintain the forests through replanting trees in reserves, on customary and estate land,

One aspect of the NRDP was development of the Adaptive Research Program (ARP). The ARP was instituted in 1983 out of concern that technologies were not being successfully transferred to farmers.

The ARP was initiated by the Ministry of Agriculture (MOA), through the Departments of Agricultural Research (DAR) and of Agriculture (DOA). The DAR and the DOA are mandated to ensure that:

1. Research programs are adequately focused on identified priority problems faced by farmers,
2. Locally specific recommendations compatible with farmers' circumstances and needs are produced, and
3. The transfer of research results is improved by strengthening linkages between research and extension.

It was noted that improvement of linkages would be essential if the research/extension system was to become more effective (Nyirenda et al., 1985). Establishment of an adaptive research capacity would have an important role in bringing agricultural research and extension more closely together. It was also considered as an opportunity for rapid diagnosis of the farmers' major social, economic and technical problems.

THE MALAWI EXPERIENCE

Adaptive Research Program Evolution

Independent Programs. Farming Systems Research and Extension concepts form the basis of the present Adaptive Research Program. In the late 1970s Malawian, German and United States administrators and researchers simultaneously began implementation of programs focusing on the constraints faced by smallholder farmers. These efforts led to the technical character inherent in the Malawi Adaptive Research Program.

The number of donors participating also led to a completely autonomous ARP functioning parallel to that of the National ARP. This program was funded from a different source and has provided interesting contrasts and comparisons to the National program. The parallel program is now in a transitory phase during which it is being brought under the umbrella of Malawi ARP.

The organization of the ARP was developed with the goal of incorporating both extension's and fanners' views in the technology generation and development process being undertaken by research through the DAR. As a result, the following organizational design was developed for the ARP as can be seen in Fig. 1 and described below.

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Adaptive Research Program Organization. The Adaptive Research Program is composed of the Adaptive Research Program Coordinating Unit (ARPCU) and six Adaptive Research Teams (ARTs). The ARPCU provides technical assistance to the ARTs and carries out administrative activities. The ARTs each work directly with producers, extension personnel and commodity research teams (CRTs). They are headquartered at the Agricultural Development Divisions (ADDs).

The ARP will be fully implemented through the ARTs after full development of staff. When fully staffed, the ARP will include nine agronomists and nine socioeconomists at ADDs throughout Malawi.

The ARTs are deployed to ADDs and are administratively responsible to the program Manager (PM) of the ADD. The ARPCU is administratively responsible to the Chief Agricultural Researcher Officer (CARO).

ARTs involve Extension Subject Matter Specialists (SMS) at the ADD level in the development of recommendations. ADD PMs preside over sessions with ARTs and SMS at the ADD level. In cooperation with the commodity research team leaders and the Adaptive Research Team Leader (ARTL), the PM considers recommendations developed by ARTs to arrive at priorities for research needs within the ADD context. The PMs are responsible for seeing that Project Officers (POs) and Development Officers (DOs) within the ADD are properly informed of all new recommendations and of ART programs and activities. The PMs ensure that approved recommendations are incorporated into the ongoing extension programs being conducted with farmers.

The operational structure of the ARP provides linkage with farmers, extension, administrators at each management level, Commodity Research Team (CRTs), National Research Coordinators (NRCs) and national and international agriculturalists. These interactions, to a great extent, have molded the research orientation of the ARP during the early years.

Farming Systems Program Development

Integration into Ongoing Programs. In late 1983, DAR identified staff to form four Adaptive Research Teams. A series of orientation seminars and workshops was undertaken over an 18-month period with support from Centro International de Mejoramiento de Maiz y Trigo (CIMMYT-Africa), the United States Agency for International Development (USAID), the International Bank for Reconstruction and Development (IBRD, WB) and Government of Malawi (GOM). The workshops signified the beginning of field activities by Malawi's Adaptive Research Program. The ARP economists were deployed to five ADDs and the ARPCU over the next four years. One ART, under funding by the German Technical Assistance (GTZ), continued to operate without the assistance of an economist while two ADDs are still without any member of an ART.

Adaptive Research Program Features. During 1986 a meeting was held by Malawian agriculturalists and administrators. At this meeting guidelines for the ARP were drafted (Principal Secretary, 1986).

The Malawi Philosophy of Adaptive Research resulted in the following goals:

1. Strengthen the Research/extension linkage,
2. Improve on the low adoption of technologies, and
3. Facilitate and direct research toward priority problems faced by farmers.

The methodology for achieving these goals was formulated during the same meeting. Subsequently, the Controller of Agricultural Services for the National Rural Development Program (CAS, NRDP) issued a directive. This directive included in the methodology the following items specifically directed at the socioeconomists and their ART Counterparts.

1. Research Program development will proceed as follows:
   a. Surveys will be the first phase of program development. These surveys do not necessarily have to be undertaken in the field. The surveys will be done by both Adaptive Research Teams and the extension staff, and a report of each survey will be produced and discussed by Adaptive Research Teams (ARTs), Commodity Research Team (CRTs) and ADD Management.
   b. All research work will be based on the findings of the survey.
2. The staffing of the Adaptive Research Team at the ADD and their mode of operation will be as follows: The Adaptive Research Team will be composed of an Agronomist and a Socioeconomist (S/E) who will be placed at the ADD Headquarters.

The methodological aspects pertaining to the S/E component of the ARP provided a guide through which the ART activities would be implemented. It also provided necessary administrative backing for the incorporation of the ARP at all levels of the MOA.

Adaptive Research Program Role. The Adaptive Research Program was intended to fill a gap that appeared to exist among producers, commodity research, extension and administrators. To carry out the mandate of the Program, the following specific objectives requiring a S/E input were identified:

1. Link research closely and continually to extension, drawing extension personnel and farmers into the technology development process,
2. Make information available to relevant institutions (e.g. those dealing with extension, input supply, credit, marketing, etc.) by describing institutional and infrastructure problems farmers face in specific areas of the country.

These two objectives could be undertaken most effectively through the combined efforts of the Agronomists and the S/Es on the respective ARTs. In some cases the S/E would be more qualified to facilitate research activities as a result of training. Examples might include issues pertaining to input supply, credit and marketing and the impact of institutions in creating of removing/reducing constraints faced by producers and their families.

It was anticipated that the inclusion of socioeconomists in the Adaptive Research Teams would provide the necessary expertise to undertake economic analysis of agronomic trials and analysis of other social and economic constraints. Initial training was such that the level of expertise in socioeconomic analysis amongst the S/Es was low. They had no actual field data collection experience outside the training program they had undergone. The type of information that they were being asked to collect was not well understood and was therefore difficult for all but a few to explain adequately.

The survey activities, the first research undertaking by the ARTs during program development, included Background Information Surveys (BIS), Informal Surveys (IFS) and Formal Information Survey (FIS). Each of these activities was a new phenomenon. To undertake both the BIS and the IFS, the S /Es had to discard most of the survey design tools that, as students, they had been taught

The socioeconomists that were assigned to participate in the Adaptive Research Teams and the ARPCU were recent graduates of Bunda or Chancellor College with no research activities having been undertaken in an official capacity for the Ministry of Agriculture. This was in stark contrast to the agronomy component of the ARP that was made up of several individuals with more than ten years of experience with the DAR. The dichotomy could not be avoided due to the small number of economists within the country.

Training and implementation barriers of this type led to difficulties in easily integrating the role of the social scientist into the ARP. In this way the socioeconomic component of the Malawi Adaptive Research Program developed.

Need for a Socioeconomic Component

The addition of socioeconomists as full partners in research became an important and unusual inclusion for the Department of Agricultural Research. By 1983 the only important microeconomic capacity existed in the Agricultural Economics and Data Processing Unit (AGREDAT) and the Agricultural Development Division (ADD) Evaluation Units (EU). Chirembo (1986) provided a summary of AGREDATs objectives, one of which was to establish and maintain a socioeconomic data base. Today, the AGREDAT economics staff consists of one expatriate economist with a Malawian counterpart undergoing advanced degree training. The Evaluation Units are staffed by hardworking but inadequately trained economists.

AGREDAT is charged with providing analysis capabilities for all DAR Commodity Groups (CGs) across the country. The Evaluation units have a similar mandate within the Department of Agriculture. The demand for the services of AGREDAT and the EUs is large. Complimentary and collaborative research efforts among the Socioeconomists within the ARP, AGREDAT and the EUs will provide basic socioeconomic coverage of Malawi when the ARP is fully staffed.

Independent Program Activities. The organizational structure of the ARP provides opportunities for informal and formal guidance by the ARPCU in development of the ART programs. The technical guidance is an important factor influencing the composition of the ART programs.

In the early years of the ARP, the socioeconomists were expected to undertake economic analysis to support agronomic trial analysis. This starting point provided a good base from which the S/E component could develop.

Two factors limited their ability to do so. Initially, there was little emphasis placed on coordinating socioeconomic analysis across the Agricultural Development Divisions. Each partial budget, the standard tool for socioeconomic analysis today, required basic information. This included prices, cost of capital, labor allocations, opportunity costs and risk measurements, among other types of data. The training program with CIMMYT provided basic concepts for the use of a partial budget. The components of the partial budgets, however, were not clearly understood. With the deployment of an ART to each new ADD, a new partial budget format and new techniques for collecting baseline information were developed. As a result, inefficiency entered into the provision of the basic socioeconomic information for the analysis of agronomic trials. Secondly, as a result of the inefficiency, few of the other socioeconomic activities that could strengthen the program could be undertaken. The more complex surveys to support the needs of other commodity groups, ARP and extension were not forthcoming. The development of socioeconomic capabilities to better analyze agronomic trial data were postponed. This became a limiting factor in the provision of a S/E research capability to meet the needs of the ADD, the producers, CGs and the ARP. Recent S/E budget and program implementation activities are reversing this trend. Concurrent with training programs being undertaken by CIMMYT, University of Florida, Consortium for International Development and numerous other organizations, both Malawian and international, was the development of linkages.

Linkage Development. Four linkage components can be identified as important to the institutionalization of the ARP. These are linkage with:

1. Commodity groups,
2. Extension,
3. Other Malawi organizations involved in agriculture, nutrition and/or rural development and
4. International agencies (e.g., CIMMYT, IITA, ILCA, etc.).

The socioeconomists have an important role in supporting and promoting these linkages. Linkages with the commodity groups, Bunda and Chancellor Colleges and international organizations have been initiated, based on full participation in the initial survey activities of the ARP. Survey activities provide the first opportunity, perhaps the most critical, for incorporating the active participation by other groups. This has led, as mandated, to the full participation of commodity groups, extension, the University of Malawi and international centers in the conduct of the surveys. The results of the surveys have, subsequently, impacted positively the on farm agronomic trials.

Commodity Research, Extension-Based Research and the Producer. The definition delineating the "territories" for research activities undertaken by commodity groups and those undertaken by the ARP led to initial confusion. The ARP was to undertake all on-farm trials but was understaffed to do this for all Commodity Groups. The ARP was charged to proceed with research, when able to do so, on major constraints faced by producers. The Commodity Groups were charged with undertaking adaptive research when they were qualified to do so (Principal Secretary, 1986). The prior research activities were to be undertaken by the ARP and extension through consultancy and collaboration with experts in the CGs. These research activities have been referred to as extension-based research.

During the first years of the ARP, research efforts resulted from participation by ADD SMS during survey activities and with Field Assistant (FA) participation in some aspects of the agronomic trial activities. Limited participation by the CGs prevailed. Recently, a greater interest has been shown by the CGs in participating in collaborative research efforts with the ARP S/Es. The reason for this has been the return of trained S/Es with capabilities that are required by the CGs. Also, an emphasis on the need to develop programs based on the findings of the surveys has provided guidance in these research activities. The producer and the trained officers are acting together as the stimulus for research activities to be undertaken by the ARTs. This participation by all groups has allowed the rapid linkage development between the extension service and Adaptive Research Program. A similar relationship exists between the ARP and farmers in the areas where trials are undertaken.

Training Socioeconomists to be Socioeconomists

Initial Training Legacy. The "socioeconomists" came from two different colleges within the University of Malawi system. These were Bunda College of Agriculture and Chancellor College, which included the major social sciences curriculum. Those from Chancellor College came to the program with a stronger social science background. In contrast, the graduates coming from Bunda College emphasized agriculture. Regardless of college, they were identified as socioeconomists to provide socioeconomic analysis for the ARP.

Limitations existed within their training that restricted their abilities to provide the mandated service. For those coming from Chancellor College, the training in agricultural systems was limited, and, with little practical experience, the opportunity to undertake successful field activities was reduced. Likewise, those coming from Bunda had very good field experience from their training in agriculture but limited experience dealing with applied economics or social issues expected to affect the dissemination and acceptance of technology. This problem was further exacerbated by the fact that the Chancellor College group was the first to be sent for advanced degree training in Social Sciences. Three individuals were sent for training, two in agricultural economics and one in anthropology. Their lack of prior field experience, outside of training, resulted in a slow integration into the ARP upon their return. There was little understanding of how to apply socioeconomic tools to the constraints that had been identified during informal surveys.

At the same time Bunda graduates assigned to be socioeconomists were undertaking agronomic trials on farmers' fields. However, this was done with little understanding of the economic or social data requirements that were needed to analyze the agronomic trials from an economic perspective.

Agronomic trials were undertaken by the agronomist team leaders with a good deal of field experience. They incorporated the sodoeconomists (Bunda) into their program as an extension of available labor. This could be done as a result of seniority, position as team leader and the fact that the S/Es were unsure of their role after informal and formal surveys were completed. Attempts were made by the socioeconomists to undertake data collection thought to be important Partial budgets were developed that relied upon official wage rates, official market prices and official cost of capital figures. The results of the partial budgets were presented in such a way that most commodity group personnel were unable to follow the analysis. This, coupled with the uncertainty about the usefulness of the sodoeconomist, led to an attitudinal retrenchment. There was an underlying feeling that there was a need for socioeconomists; however, it was unclear what form this need was to take. The sodoeconomists were inclined to provide the labor necessary to support agronomic trials. This restricted the level of activities designed to identify mechanisms that would lead to the transfer of technology. At the same time the Chancellor College S/Es in the United States were being trained in anthropology and macro economics rather than in economic anthropology or sociology and microeconomic analysis.

As a result the agronomic program was affected by not having adequate socioeconomic support Today, this legacy of training is being overcome as the Chancellor College graduates participate in actual farm-level data collection activities to provide the information necessary for use of their learned socioeconomic tools. At the same time, the Bunda College graduates are now learning the tools that will allow them to initiate useful programs directly upon return to their duty stations. A crucial integration step for the ART S/Es coming back into the program should not be avoided. This step is the commitment by each of them to promote standardized data collection activities that support the agronomic trial program and national goals.

In-Service Training Activities. The Adaptive Research Program training opportunities have been focused on the ART professional staff during the first three years of the program to a great extent. While this training component was generally needed during this period to upgrade the POs capabilities, this has largely been accomplished. Today it is necessary for more focus to be incorporated into training programs. For the S/E at the PO level, there are several focal points that vary between the ARPCU and the ARTs due to their differing mandates.

The ARPCU S/E will need both advanced technical skills and administrative skills to ensure proper functioning of the ART S/E capabilities. Short courses in agricultural administration can provide this capacity. Training in project administration would be available during advanced degree training and should be incorporated into a Ph. D. program for the ARPCU S/E and for any who come after the present holder of the position. Secondly, for both technical and administrative reasons, it is necessary that the skills of the ARPCU S/E be greater than those of his ART S/E counterparts. This will provide the option for the ARPCU S/E to undertake in-service training programs when it has been observed that data bases are adequately developed to undertake useful analysis with more sophisticated tools. The S/E program will provide services for other groups (CGs, Planning Division, University, extensions, etc) more effectively after the ARPCU S/E is trained both administratively and technically at the highest level

The ART S/E play a very different role but one that is no less important. The initial goal of the ART S/E is the provision of information to evaluate agronomic trials. Training necessary to undertake this function will have been accomplished after training to the M. Sc. level but should not exclude Ph. D. training as the program develops. Individuals who are in the ARP at the present time have also been trained in Farming Systems Research and Extension (FSR/E) activities through on-going workshops provided by CIMMYT and other

groups. The need that exists today is for the practical training of socioeconomists in the day-to-day operation of the agronomic trial program. This is especially true of the ART S/Es that were trained at Chancellor College. This training opportunity exists through short courses provided by the International Institute for Tropical Agriculture (UTA), CIMMYT and other IARCs, not to mention participation with the ART agronomist in undertaking his/her daily activities.

The latter method should not be relied upon too heavily due to conflicts associated with data collection activities. By their very nature, they must be undertaken at the same time that agronomic operations are being undertaken. Therefore, it is important for the Chancellor-trained S/Es to undertake short course training in agronomic trial design, implementation and analysis. This training would provide the necessary understanding to dearly identify weaknesses in their support programs for both the ART agronomists and other CG personnel

An important part of the program for training should and will come from the ARPCU when Malawian leadership prevails after training programs have been completed. In the interim, training of the ART S/Es will be undertaken by the ARPCU expatriate S/E working directly with the two ADDs where S/Es are presently deployed. In the six Adds with no S/E, five of which are operating, it is necessary for the ARPCU expatriate S/Es to provide basic services to the agronomic component of the programs.

National Program Perspective

Autonomy Among the Adaptive Research Teams. The autonomy that exists among the ARTs has resulted in S/E activities suffering from the following chronic problems:

1. Non-comparable experimental results,
2. Inefficiencies in data collection, and
3. Loss of focus in linking fanners' needs to national goals.

These problem areas are offset, to a great extent, through benefits accruing to the national research effort. These benefits include a closer link of research to extension, better feedback from both farmers and researchers, an opportunity to conduct goal-oriented research based upon needs of farmers and identified researchable constraints. These plus the fact that all research is undertaken with multidisciplinary research teams have led to useful results even as the ARP S/Es try to remove some of the barriers that they have encountered.

The productive autonomy of an ART may be misconstrued to mean complete autonomy that has resulted in the problems mentioned above. This has had the negative effect of reducing the ability of the ART S/Es to help "fine tune" technologies for site-specific phenomena of particular ADDs.

The S/Es should use standard data collection techniques and instruments for the collection for the agronomic trials. This may be collected autonomously but can then be compared with data from any of the other ADDs. The successful collection of standardized information will provide data necessary to:

1. Analyze agronomic trials in a particular ADD,
2. Make cross-ADD comparisons that, in turn, will provide the basis for multi ADD or national policy statements,
3. Promote a move away from partial budgeting of agronomic trials (the first step in economic analyses) to more sophisticated and useful modeling activities,
4. Develop information systems on a wide variety of non-agronomic issues that may have been identified in the survey activities.

Without standardization the maximum benefits of the ARP are unobtainable. The socioeconomic component of the ARP should provide useful information that can be compiled across the ADDs.

Standardization of data collection activities by the socioeconomists has begun recently. The two ADDs with S/Es have undertaken coordinated activities to provide baseline information for agronomic trial programs. At the same time, socioeconomic programs that focus on labor, capital, managerial and institutional factors of production are being budgeted for the 1989/90 period. These will be instituted simultaneously with the provision of annually generated baseline data which is required.

Opportunities for Comparison of Cross Sectional Data. Cross-ADD comparisons of ART socioeconomic output will provide the opportunity to link microeconomic results to macroeconomic policy initiatives. Due to the administrative nature of the ARP, this impact can only be expected from activities undertaken by the S/E in

the Adaptive Research Program Coordinating Unit. This action, by itself, would justify the existence of a national unit to coordinate activities among the ARTs. Initiatives to provide the data base for this undertaking were formulated by all the S/Es in the ARP who were in Malawi prior to their departure for advanced degree training. This was done under the direction of the Malawian ARPCU socioeconomist. Guidance of this sort provided initiatives in the areas of

1. Labor allocation by gender and age to provide information on opportunity costs,
2. Collection of marketing and transport information that provides basic data on farm gate prices,
3. The determination of effective interest rates being charged to participating farmers on input loans,
4. Collection of data on the characteristics of participating farm household members to help determine the reasons for acceptance or rejection of technologies.

Each of these items provides information for analysis of any agronomic trial When standardized they also provide the ARPCU S/E with information across ADDS in a form that can be used to draw conclusions for national policy recommendations.

The S/E, both at the ARPCU and in the ARTs, must ensure that results from survey activities that are found to be constraints in more than one ADD be prioritized accordingly. Socioeconomic programs designed to reduce or remove these constraints can then be coordinated and undertaken jointly between the socioeconomists in their respective ADDs while providing comparable data for cross-ADD analysis. Examples of this type of S/E program activity would be surveys to determine the availability and localities of indigenous pesticides as substitutes for interrupted supplies of manufactured pesticides. This example has implications for both capital and institutional factors of production. Another example is the determination of maize varieties being produced by smallholder farmers. This would provide the maize commodity team with information that would directly impact on policy makers and donor agencies. These activities could result in alternative sources for poorly supplied and expensive chemicals and an actual percentage of improved maize varieties being taken up by the smallholder, which in turn would impact directly on agricultural recommendations.

These aspects of the program should be undertaken by both the ARPCU and the ARTs in harmony. For the S/E this means that their efforts must be concentrated on the collection and analysis of information for agronomic trials and many equally important components. These generally will result from constraints associated with capital, labor and managerial productivity. Analysis and comment on the institutional factor of production would be made from the ARPCU as a technical service.

Adaptive Research Team Composition and Leadership Roles. The composition and leadership roles within the Adaptive Research Program were predetermined on the basis of DAR-perceived needs. The inclusion of young S/Es, directly out of college, teamed with agronomists who had a varying degree of field experience led to an immediate hierarchical arrangement. The agronomists were assigned as team leaders and the S/Es as team members. This role predominated in each ADD with an ART.

Today, due to training schedules and original design, the stage is set for returning S/Es to be thrust into positions of team leaders in five of the eight ADDs. The fact that the S/Es will be working without counterparts, in most cases for a minimum of one year, offers good opportunities for the institutionalization of the socioeconomic component within the ARP.

The programs that are budgeted for 1989-90 underscore these opportunities. Research work of the S/Es will focus on the following programs, which expand the scope of previous activities undertaken by the ARP S/Es:

1. Cost of production estimates for wheat in Mzuzu ADD (Phiri, 1988),
2. The impact of barter trade along the Zambia border and its impact upon the production of Sunflower (Phiri, 1988),
3. Break-even analysis to estimate levels of output necessary to profit from provision of dry-season hay storage for large ruminants (Nyondo, 1988; Phiri, 1988),
4. Benefit/cost analysis of the substitution of a herbicide for labor required in hand weeding. This will be done primarily as a secondary literature review substantiated on the basis of actual field data from one ADD (Gillard-Byers, 1988),
5. Collaborative research by the S/Es with the Maize Commodity Group to estimate hectarage under improved maize varieties (Gillard-Byers, 1988),

6. Collaborative research efforts by the S/Es with the Agroforestry Commodity Team. This will be undertaken to determine the socioeconomic basis for systematizing the use of *Acacia albida* as an alternative to fossil fuel-based nitrogenous fertilizer (Gillard-Byers, 1988),
7. Survey activities to document types, availability and production possibilities for indigenous pesticides as a substitute for chemical alternatives that are in short and erratic supply (Phiri, 1988; Gillard-Byers, 1988),
8. The institution of post-trial analyses of producers. Focus would be the perceived positive or negative benefits from agronomic research trial results as seen through the farmers' experience (Nyondo, 1988; Phiri, 1988; Gillard-Byers, 1988),
9. Agronomic and Socioeconomic Trial activities using Pre-Release Varieties (Chanika et al., 1988; Gillard- Byers, 1988),
10. Informal Survey Activities focusing on Production, Consumption and Marketing in Mzuzu ADD, Karonga ADD and Salima ADD (Nyondo, 1988; Gillard-Byers, 1988; Phiri, 1988),
11. Credit and Marketing by Women-Headed Households in Nkhata Bay Rural Development Project (Phiri, 1988).

These are each ambitious programs. It shows clearly the growth in the S/E component of ARP activities. Similar programs will be undertaken by the S/Es as they return from their training. The activities listed above compliment the provision of basic information for the maintenance and development of the agronomic trial program as delineated earlier.

The S/E trial program includes collaborative research with CGs, direct participation of extension counterparts and increased emphasis on participation with lARCs. Expansion in the scope of work undertaken with the Women's Programs Officers in the ADDs is a high priority. The continued focus on constraints identified as priorities in the Informal Survey process should continue to guide program activities. However, the expansion in the scope of S/E activities presents longer term problems in the administration of the ARP

The objectives of ARP are predominantly oriented in the near term to agronomic trial activities to introduce, "fine tune" and promote dissemination of technologies generated by CGs. As such, there develop perceptual goals that may, on the surface, seem to conflict between the agronomic and socioeconomic components of the ARP. While the agronomic component of the program will undoubtedly continue focusing on land productivity issues to the exclusion of other issues, the S/E component will be drawn more toward answering questions pertaining to labor, capital, managerial and institutional constraints.

Adaptive Research Program Coordinating Unit Technical Services. The ARPCU has the responsibility for providing technical services to the ARTs. The socioeconomist's role in providing these services takes on administrative as well as technical overtones. The initiatives mentioned previously have provided a strong base from which the socioeconomic component of the program can develop. The key is continued technical and administrative guidance from the S/E in the ARPCU. This support would take the form of

1. Consolidation and distribution of socioeconomic and agronomic results from the ADDs.
2. Leadership in the uptake of more sophisticated analytical tools when the data base is available,
3. Obtaining a clear knowledge of limitations that exist within any ART that restrict the accomplishment of socioeconomic tasks followed by the necessary effort to remove these limitations either through direct intervention or administratively through the National Research Coordinator,
4. Direct interaction with CGs on issues of socioeconomic data collection activities to support programs,
5. Continued direct communication with CIMMYT and expansion of linkages to other IARCs in area of socioeconomic analysis,
6. Leadership in the use of manpower resources within the ADDs (especially the Evaluation Unit's enumerators)
7. Institution of proper budgeting procedures by the ART socioeconomists to ensure funding of program on an annual and quarterly basis,
8. The production of multi-ADD recommendations on the basis of economic and social analysis,
9. Continued backstopping on adaptive research initiatives in other parts of the world that may provide insight for the ART socioeconomists,
10. Continued emphasis on and leadership in moving the ART socioeconomists into areas of investigation previously avoided. These might include alternative means to maintain soil and water resources (ex., *Acacia albida),* land tenure issues resulting in fragmentation of holdings (ex., minimum farm size that can be self sufficient for targeting agronomic trials), substitution of appropriate capital for labor to reduce labor peaks (ex., oxen traction trials or herbicide alternatives),

11. Leadership in the expansion of post-trial analysis of agronomic trials to document positive and negative trial results from the perspective of the producer.

Opportunities for Goal-Oriented Research. To be an effective research component within the DAR and DAO, the Adaptive Research Program Socioeconomists must maintain skills learned during advanced degree training. Goal-oriented research designed to hone and maintain skills has not been exploited for the S/Es due to little understanding about their capabilities. The S/Es in both the ARPCU and ARTs should be requested to undertake one research project annually designed to improve these skills while impacting on a major constraint. The project would by necessity result in the application of analytical tools to researchable problems in Malawi. These might include operations research, demand analysis, incorporation of natural resource concepts, risk analysis and other tools or concepts that are not yet ready for exploitation due to limited data bases. As an example, if a socioeconomist has been trained in macroeconomic price analysis, he/she should undertake an activity in that area to ensure continued competency in the area of expertise. This need not contrast with the mandate of the ARP but would require more flexibility in its interpretation than has been given during the first years of the program. It is, however, a need that must be met while simultaneously developing and institutionalizing the ARP. It is up to the S/Es in both the ARPCU and ARTs to ensure that this opportunity is promoted. Without continued vigilance, the S/Es' tools will slowly but continually fall into disuse at the expense of the ARP, DAR and the Malawi producer.

When the ARP is fully staffed, it will have the premier microeconomic capability in the country, and perhaps the region. Therefore, maintaining the skills of these individuals is a high priority and should be nurtured at both the ADD and Ministry levels. As collaborative efforts between the S/E within the ARP and other groups expand, the demand for these skills will increase. Only those S/Es that are encouraged to maintain high levels of competency in the use of socioeconomic tools will be able to respond effectively to meet this demand.

INITIAL EFFECTS OF SUPERIMPOSING SOCIOECONOMISTS ON A STATION-BASED RESEARCH PROGRAM

Economic Analysis and Anticipated Trends

During the first four years of the ARP, socioeconomic analysis has concentrated on development of partial budgets for the evaluation of agronomic trial results. During the first three years, there was little understanding of the actual data that were required as a basis for the partial budgets. Advanced degree training, continued training by CIMMYT and common sense on behalf of the S/Es have, for the most part, put the problem behind the ARP. The anticipated trends in the S/E component of the program will continue to focus on trial analysis. However, the type of analysis will move away from partial budgeting, which has severe limitations for the analysis of intercropping systems, toward mathematical programming using data generated within the ARP and data available from secondary sources. This growth trend within the Adaptive Research S/E program is inevitable. Coupled with the new tools that will be employed is the provision of information on risk characteristics of producers in Malawi to better assess the viability of technologies.

The S/E will need to consider the usefulness of training extension counterparts in basic farm management techniques applicable to smallholder agriculture. The choice of providing farm record keeping techniques to the farm family would introduce useful budgeting capabilities and also provide additional information to a growing data base.

A coordinated effort to generate S/E results to guide the CGs' research efforts will coincide with the development of agronomic analysis capability. The focus of the efforts will result from S/Es actively pursuing research activities of high priority to the CGs that coincide with constraints identified by producers. These efforts will be designed to do the following:

1. Provide services to the CGs in areas in which they maintain only limited expertise such as survey design, implementation and analysis.
2. Undertake research designed to impact on constraints faced by producers that are the result of labor, managerial, capital or institutional factors of production. The expected focus would result from Informal Survey and Formal Survey activities. To Date, the majority of research undertaken has focused on land as a factor of production.
3. Continue to develop the data collection and analysis capability of the ARP to provide information for advanced topics of research in the ARP and for provision to the ministry of Agriculture Planning Division for macroeconomic policy decision making.

Social Analysis Capabilities-Need for Linkage with Experts

Analysis of constraints that have a cultural basis has been difficult during the first years of the ARP. This is due to a training regime that did not prepare the S/E for identifying societal mores or family beliefs. The fact that Malawi has many different cultural and religious beliefs aggravates the site-specific identification of these constraints. The S/Es will need to improve their capabilities to better identify and characterize these constraints before effective methods to reduce or remove them can be developed. This may be accomplished through in-service and IARC training as well as training during advanced degree work. Emphasis should be placed on course work in rural sociology and/or economic anthropology as a component of required course work. Exogenous cultural and/or religious constraints may severely retard the acceptance of a technology.

Ability to Participate in Program Development. The ARPCU S/E should be allowed to provide guidance for the ART S/Es in their initial program development activities. It is important that the programs that are developed across ADDs are done so with national and farmer goals in mind. National objectives must be considered in the design of research activities. The ART S/E has limited information relative to the ARPCU S/E. The ARTs should use the ARPCU S/E as a resource to strengthen their ADD programs. In the process of developing programs, the ARTs should recognize that their programs may need to be expanded to reflect these goals.

FUTURE ROLE OF SOCIOECONOMIC IN THE ADAPTIVE RESEARCH PROGRAM

Implications of Reassignment of Socioeconomists

Social scientists participating in the day-to-day research activities of the Department of Agricultural Research is a relatively new phenomena. As such it has been the inclination of the DAR to reassign S/Es soon after they have returned from training. While the demand for economic services is ever increasing, it is imperative that the ARP S/Es be assigned a posting in the ADDs immediately after training. For continuity, the S/Es should work in an ADD for a minimum of four years, which would allow a full cycle of work, from initial agronomic program to verification, to be completed.

The S/Es are now being trained in production economics, farming systems, marketing, operations research, etc. The training will provide them with tools necessary for undertaking microeconomic analyses. Movement to Ministerial level positions dealing with macroeconomic policy issues may put them in an inappropriate environment directly out of training. The hands-on experience of working in the field will define their ability to promote national objectives at a later time.

Each reassignment of a S/E results in the loss of microeconomic analysis capability for thousands of farmers and their families. It negates S/E support for CGs for a minimum of three years due to training requirements. It removes the ability to test technologies for socioeconomic viability. Reassignment of the S/Es restricts the DAR's capacity to meet the goals of increasing incomes while maintaining the natural resource base. This is a result of a shortage of microeconomic data for basing macroeconomic policy decisions.

Microeconomic Capacity for Country Development

The ARP S/Es provide the basic component for the development of a microeconomic core activity within the ARP. The CGs do not have the capability necessary to determine the economic viability of their research programs at the present time. AGREDAT is understaffed with few expectations for hiring and training economists. It is likely that the ART S/Es will be called upon by the CGs to participate in collaborative research efforts. This entails providing S/E input at the design, implementation and analysis stage. Given the demand for the S/E analysis that will be generated internally by the CGs and through extension, the prioritization process will weed out those programs that are not truly collaborative.

The results that will come from collaborative research efforts of the S/Es in the ARP will provide information for use by the DAR and DAO at the MOA Headquarters and, when cleared, the IARCs. The information will be available in the library services for use by the University or other groups in the country.

Necessity and Ability to Participate Fully as Collaborative Researchers

A key to the success of the ARP in Malawi is the ART members' ability to develop collaborative research programs with other CGs. Without collaborative efforts, the expertise within the ARP will not be sufficient to generate the necessary technological innovation and acceptance to pull the Malawi low-resource producer out of the vicious cycle. The ARP S/E component has the potential to lead useful research efforts in collaborative modes with extension, commodity groups and farmers. The collaborative efforts recently developed into program activities as a result of survey activities may show how these efforts can pay off in the near term.

SUMMARY

The Adaptive Research Program socioeconomic component will be called upon to provide more analyzed data to help the policy maker in his/her decision-making process. To ensure that this demand for information is met, the S/Es in the ARP must plan ahead. Direction for this planning should come from the ARPCU S/E after discussions with parties who maintain an interest in the outcome of such planning. These would include the DAR, DOA, Extension, the University of Malawi, the ARTs and the producer.

Planning for the future must, first, include the provision of data to evaluate agronomic trials analysis. The basis for the Adaptive Research Program is its agronomic trial capability to "fine tune" technologies. Thus, the initial strength of the ARP is the socioeconomic evaluation of agronomic trial results. When the provision of this service has been assured on a continual basis, the ARP S/Es will be requested to undertake a higher percentage of programs dealing with issues affecting constraints resulting from labor, management, capital and/ or institutional factors of production.

Research activities focusing on these "other" factors of production have now been budgeted by the ARP S/ Es. This will provide the opportunity for addressing a broader range of constraints identified by producers and "experts." It also provides the opportunity for the ARP S/Es to maintain competency in the use of their economic tools, a critical consideration for country development

The activities undertaken by the S/Es will call for the use of more sophisticated tools. The transition will not be possible until the data base to support the tools has been developed. These data are now being generated. They will provide the opportunity for the microeconomic capability of the ARP to progress more rapidly.

Linkages between CGs will create an increasing demand for both the data and the expertise of the ARP S/ Es. The S/Es should be able to respond if proper direction is provided by the ARPCU S/E with the support of the National Research Coordinator. Without this direction and support, the S/E's capabilities will not be exploited. This will result from non-comparability among ADD ART results. The ART S/E is not able to standardize without direction from the ARPCU socioeconomist due to logistical and communication problems.

Expansion in the scope of the S/E program, combined with the generation of a strong data base, use of the proper socioeconomic tools, a moderate degree of standardization and strong leadership from the ARPCU socioeconomist may be necessary to fuel the ARP. The anticipated result would be stronger linkages, a broader array of potential recommendations, more practical and theoretical skills among the S/Es and a greater opportunity for the ARP to impact on smallholder production, consumption and marketing constraints.

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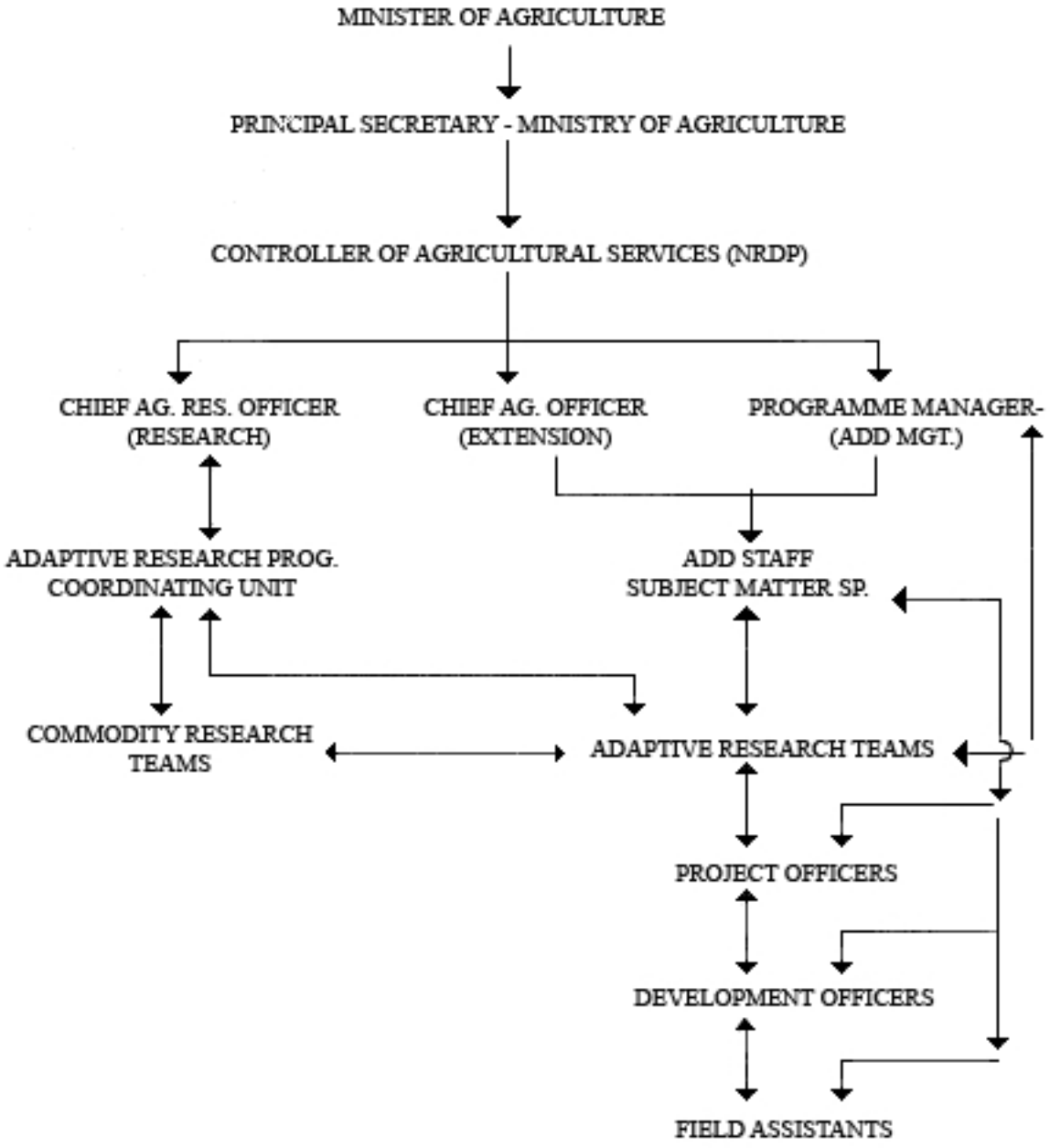

Fig. 1. Generalized flow chart of the Adaptive Research Administrative and Technical channels.

THE ROLE OF FARMER TESTING GROUPS IN RESEARCH AND EXTENSION: SOME EXPERIENCES IN BOTSWANA

S. Masikara, F. Worman and G. Heinrich[1]

INTRODUCTION

Farmer participation in agricultural research and improving the linkages between research and extension have recently received much attention. Increasing farmer participation has been a prominent theme of numerous articles and workshops (i.e., Farrington and Martin, 1987).

In one part of Botswana (around Francistown), the Agricultural Technology Improvement Project (ATIP) has completed three seasons of actively involving farmers in the research process through farmer testing groups. More than 250 farmers, researchers and extensionists have been collaborating to test some promising technologies for improving farm productivity through farmer-managed, farmer-implemented (FMFI) trials.

This paper reviews ATIP's approach to farmer participation and presents operational approaches for two types of farmer groups.

THE BOTSWANA SETTING

Botswana is located in the central part of Southern Africa and is a semi-arid country receiving 450-500 mm of rain a year. Poor soils and a highly variable rainfall distribution between years, within years and even between land areas in a village create a harsh environment for rainfed crop production. Following six years of drought, farmers received more than double the 30-year-average rainfall during the 1987-88 cropping season. With rain came pests and crop damage due to flooding.

Botswana's main sources of foreign income are diamond and beef exports. Approximately 70% of the population consists of limited-resource farmers engaged in small mixed livestock-crop operations. Farm families generally rely on livestock (both cattle and small stock) and off-farm activities for their subsistence.

Average crop yields are approximately 250 kg/ha, but many plots failed yearly during the recent six-year drought. The mixed cropping system is based on sorghum with millet, maize, cowpeas, groundnuts and melons as secondary crops. The traditional cultivation system is to plant small areas by broadcasting seed and ploughing with a mouldboard plough. Oxen, tractor and donkey traction are used, with only half of the households controlling their own traction. Yields are low, and farmers produce only about 30% of the country's basic grain requirements in an average year.

GROUP APPROACHES IN BOTSWANA

Groups (and committees) are a major feature of village life in Botswana. Most villages have a village Development Committee, a Parent Teachers Association, a Social Health Committee, a Farmers Committee (to advise and assist the Agricultural Demonstrator) and one or more special-purpose agricultural groups (drift fence, small stock dosing group, etc). In 1975 an Agricultural Group Development Program was established by the Ministry of Agriculture with the aim of broadening extension outreach. Agricultural Management Association Officers are posted to the Regional Agricultural Office and have primary responsibility for supporting Agricultural Demonstrators in helping farmers increase production through group extension methods and cooperative group action. Unfortunately, the majority of agricultural groups exist in name only (Ntseane, 1986).

Groups that have a specific focus and provide individual benefits for members seem to have the best chance of success whether or not they have a formal legal organization. Part of the reason ATIP testing groups appear to be popular is that they do have a focus, and the benefits accrue to individual members based on their own input.

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When groups are discussed in Botswana, and in most places, the image is one of a formal, legally recognized organization that exists to perform a specific function with all members providing an input to the group activity. A good example of such a group is an agricultural production cooperative. The ATIP testing groups are not organized in this way but are instead associations of individuals who are working on their own trials and sharing their experiences with others. In a study of the Francistown options testing groups, Ntseane (1988) found that group members did not favor the formation of more formal, legalized groups.

ATIP EXPERIENCE WITH GROUPS

In 1982 the Government of Botswana and USAID initiated the Agricultural Technology Improvement Project to conduct on-farm research (using two field teams), primarily in crop production technologies. The on-farm research program of ATIP has had two primary goals: (a) to identify and test relevant, improved arable production technologies; and (b) to develop appropriate, low-cost methods for on-farm research and extension ATIP took as its point of departure the farming systems approach to research. One of the cornerstones of this approach is a "bottom-up" perspective of the research and development process (Norman, 1980).

ATIP began its research work by investigating modified tillage planting practices and by conducting an in-depth diagnostic study of the farming systems through a multi-year, multi-visit study. Most of the trial work was aimed at answering technical questions and so was carried on in a researcher-managed and –implemented (RMRI) and researcher-managed, farmer-implemented (RMFI) mode. This type of trials work required a major investment of researcher time, so trials were limited to the most important problems. It was soon realized that the complexity of household-farm interactions required increased farmer involvement in the selection of technologies for testing, the design of trials and the assessment of trial outcomes. The farmer needed to be included as a partner in the process, not just as a client

The emphasis for the last three seasons has been to promote the partnership of farmers in research and extension activities as other than clients. Farmers can contribute to research and extension from their experiences by communicating with researchers, extensionists and other farmers. In addition, farmers can expand their horizons and concept of what is possible through this communication and through training activities.

One of the primary methods of attempting to increase the interaction with farmers and extension workers has been through farmer groups. ATIP has identified four types of farmer groups. Three groups-design groups, focused testing groups and researcher-managed options testing groups-are discussed elsewhere (Norman et al., 1988). We have added a fourth group, the extension-managed options testing group, to the typology (Table 1). There are two types of farmer groups discussed in this paper, the researcher-managed options testing group and the extension-managed options testing group. The descriptions of the operations of the options testing groups given below are based on the Francistown ATIP team experience.

ATIP Francistown began researcher-managed options testing group work three seasons ago with a group of 12 farmers testing one technology in one village. The second year groups were formed in two additional villages, including 97 participants, and testing was expanded to five major and several minor technologies. During the current year approximately 130 farmers have signed up to test more than a dozen technologies in the three groups. ATIP and the extension service are completing the first season working with the extension managed options testing group.

RESEARCHER-MANAGED OPTIONS TESTING GROUP

Objectives

Researcher-managed options testing groups are organized as a part of the overall research strategy of the ATIP Francistown team. The objectives for the groups are as follows:

a) to test a broad range of innovations (technologies) under FMFI conditions for increased productivity and grain yield dependability;
b) to involve farmers and Agricultural Demonstrators (AD) in the systems/technology development process;
c) to determine what types of innovations are most appealing to farmers with different resource situations (recommendation domains);
d) to refine further the use of the group process for including farmer input into farming systems research.

Participants

There are three primary sets of regular participants in each group:

a) the ATIP research staff, composed of agronomists, agricultural economists and animal scientists in Francistown; and ATIP village staff consisting of a senior technical officer and four to six enumerators and/or field assistants;
b) the village AD;
c) village farmers who join the group.

Occasional participants include on-station researchers who are collaborating in particular trials and district and regional extension staff (Regional and District Agricultural Officers, Crops Production Officer and the Regional Manager of ALDEP-program to provide equipment to resource-poor farmers).

Procedures

Between cropping seasons, the ATIP Francistown staff meets with regional and district extension officers, researchers at the experiment station and village-level ATIP staff to discuss plans for the coming year's research. Technologies to be tested by the farmer groups, as well as those to be tested in researcher-managed trials, are identified by these parties and form the basis for the ATIP work plan.

Approximately two months prior to the normal beginning of the cropping season (the onset of rains), ATIP staff attend a traditional village meeting at which the Francistown staff and the senior technical officer in the village make a formal report describing the results of the previous year's research (both researcher-managed trials and farmer group trials). They also describe the plans for farmer group activities for the coming year and invite anyone wishing to participate in the farmer group to attend the first group meeting.

Before the first group meeting, the Francistown staff hold a workshop for village staff to assure that all new technologies, particularly mechanical technologies, are understood and that the village staff can teach farmers how to use new equipment Trial procedures are reviewed, and data collection forms are discussed. Village staff is also asked for suggestions to make groups function more smoothly and efficiently.

Four to six weeks after the village meeting, the first farmer group meeting is held, chaired by the ATIP village senior technical officer. (The local AD and any interested district or regional extension staff or experiment station researchers are invited to attend farmer group meetings.) At this meeting the Francistown staff reviews a wide range of technologies available for FMFI testing in terms of their uses and input requirements (Table 2). These options include technologies tested in farmer groups previously, those tested in researcher-managed trials and ready for broader farmer testing, technologies (particularly seed varieties) that experiment station researchers wish tested and technologies that the extension staff wish to have included. Farmers are encouraged to make additional suggestions.

The trial procedures are suggested by the research staff. The procedure is generally to have a side-by-side comparison (10 m x 50 m plots) planted on the same day. The technology being tested is in one plot with the traditional broadcast plough-down technology in the second plot Variety trials involving two to five varieties are done in side-by-side plots, again planted on the same day and using the same planting method across plots.

Farmers are then asked to select one or more technologies that they want to test on their own fields. ATIP village staff record all trials selected, assist farmers in staking the trial plots and provide seed, fertilizer and other inputs required for the particular trial. Technologies involving new machinery and variety trials tend to be limited by material availability.

Typical technologies tested include a tractor-mounted plough/planter; an animal-drawn two-furrow plough; a double ploughing / broadcast planting system; an animal-drawn row planter and two types of hand-held row planters; phosphate fertilizer, crop variety trials, the use of short-season crop varieties to reduce the risk of crop failures, and the use of fodder crops.

In subsequent monthly meetings, the trial procedures are discussed several times, and, where necessary, village staff visit farmers to assist in implementation (particularly with new equipment). During monthly meetings farmers report on trial progress, problems and their observations concerning the technologies Francistown staff visit each trial at least once during the season to record details of the trial and assess the accuracy of its implementation.

Group meetings serve as a forum to address solutions to particular problems, such as insect infestations, and also to allow senior extension staff and experiment station researchers an opportunity to discuss relevant topics with a group of farmers. These meetings often produce in-depth discussions between fanners and visitors and

have been responsible for the modification of some experiment station research so that it more accurately addresses the farmer's actual problems.

Late in the season, the farmer group members participate in a field day. The field day is organized by the farmer group and ATIP staff with input, and sometimes exhibits, from extension. Selected trials, both RMFI and FMFI, are visited, and the farmer on whose field the trial is located describes the trial and her/his observations concerning it. Farmers from other villages attend these field days as do district and regional extension staff and experiment station research staff. There is generally a very lively discussion of each trial.

When trials are harvested (by the farmer), the yields are weighed and recorded by the village staff. A final group meeting is held to discuss the results of each trial The Francistown staff conducts a formal end-of- season survey of participants and analyzes the data collected. This information along with researcher and extension evaluations of the groups is presented in a progress report for distribution to village staff, extension, experiment station researchers and other interested parties.

Training, Staff Commitment and Logistics

Village-level staff participate in a workshop to receive training in any new technologies and to practice with new equipment Trial procedures, material distribution (seeds, machinery, etc) and data collection procedures must all be reviewed and agreed upon. This usually takes place in the context of a general workshop on the entire research program and involves one day at a central location and one or more visits to each village. One to two additional field assistants are employed part time to assist in staking fields and other tasks to free more senior village-level staff to make field visits and to train or assist fanners with implementing trials.

Group members receive training in trials implementation procedures, the theory behind the technologies (where appropriate) and the use of new equipment

The village AD is invited to attend monthly meetings and to make any materials or equipment normally available through government programs available to group members. Other extension staff participate as they choose or by special invitation.

Francistown staff is committed to planning meetings with experiment station and regional extension staff-part of the planning process for the entire research program. The Francistown staff organizes and conducts training for village staff, and one or more members attend each group meeting. The staff also organizes the food and transportation for field days with actual preparation being the responsibility of the groups. In addition, the Francistown staff devotes time to field visits to train village staff in assessing the trials and to address specific problems that may arise.

Materials and equipment for the trials come from several sources. The research station provides seed, fertilizer and some equipment for trials. ATIP provides other equipment for trials and support equipment, such as scales to weigh the harvest. To date, training costs have not been great as they are part of normal training activities. One of the major costs has been for field days, amounting to approximately US $400 per village for food. Transportation for Francistown staff and for field days is provided out of normal government funds.

Limitations

Several limitations to the group approach, as we have used it, have been identified. These include the following:

a) The farmer groups do not have an organization apart from the research program. They have been established as a part of the overall research program and as such may not have a role to play after the project terminates.
b) Farmer groups tend to serve as a focal point for extensionists and researchers to interact with farmers about subjects that are not part of the trials work. While this type of exchange is useful for all parties, it may become too extensive and thus have a negative effect by taking time needed for actual trials work. The groups, because they meet on a regular basis, also become a focal point for allowing out-of-country visitors an opportunity to meet with a large group of farmers in one location. Again, occasional visitors are helpful to the group, but too many detract from group activities.
c) A continuing question is how much support, in terms of seed, equipment and other inputs, should be provided by researchers. It appears obvious that any available new equipment must be provided if farmers are to conduct appropriate trials. However, it may be argued that farmers should provide all locally available inputs. ATIP Francistown has taken the position that providing small, measured quantities of seed for standard-size trial plots provides better comparison than having farmers provide their own

seed and determine the quantity sown. It also aids in trials analysis, and seed quantities do not exceed 200 g/plot for small grains or 1 kg/plot for large-seeded crops.

d) A related question is at what point farmers should stop testing and start adopting. Farmers have indicated an interest in planting larger areas with ATIP-provided inputs. The problem then becomes one of determining when a farmer is conducting a large-scale trial (which may deserve support) and when the trial is actually an adopted technology and should be fully farmer supported. There is an additional question of what to do when a piece of equipment is not locally available but farmers wish to use it extensively.

e) One of the problems associated with group trials is the desire of participants to have researchers visit the trial sites on a regular basis, as is done with researcher-managed trials. With a large number of farmers participating in groups, individual field visits by research staff are impractical. Yet there is a strong desire for such visits on the part of the participants.

f) Having farmers select their own trials rather than having researchers assign trials means that more popular options may be heavily tested while other options are not tested at all.To date we have accepted this as the price of allowing greater farmer input and freedom.

g) Conducting trials may be very difficult for farmers who do not control their own draught power, e.g., many cattle were killed by drought, leaving some farmers with insufficient oxen to form a team. As a consequence, many farmers were forced to hire tractors. Tractor drivers were very reluctant to perform "small plot" work. Therefore, many fanners who signed up for trials were unable to implement them.

EXTENSION-MANAGED OPTIONS TESTING GROUPS

Objectives

The extension service in Botswana is currently very committed to administering drought relief programs. Thus, the traditional role of extending recommended agricultural technologies has been greatly reduced. The 1987-88 annual report from extension in the Francistown Region states that virtually no extension was done this year and that 95% of the AD's time was taken up with administration of government relief programs. Further, a single AD may have well over 500 households under his/her responsibility. Without a good communication system, many of the constraints these households face may go unaddressed. The farmer group approach offers a means of working with a number of farmers at one time, thus improving the efficiency of the AD. The objectives of the extension-managed farmer testing groups are as follows:

a) to provide a method for ADs to increase their efficiency by addressing a large number of farmers (on technical issues) at once, rather than having to make numerous individual visits to households and fields (the group format allows the AD to perform a teaching function at the beginning of the year and a backup function throughout the cropping season through monthly meetings);
b) to provide a forum for researcher backup in extension activities;
c) to provide a test to see if farmer groups are practical under extension conditions.

As was discussed above, ADs are officially encouraged to work with groups of farmers, but to date the system has not been employed for the testing of extension recommended technologies in the Francistown Region.

Procedures

Prior to the cropping season, A TIP staff met with regional agricultural officers to discuss establishing a pilot extension-managed options testing farmer group. With the Regional Agricultural Officer's approval, the DAO identified one extension area for the pilot group. The DAO and the AD from the area met with ATTP staff to discuss the group work. The Regional Crop Officer and the ALDEP manager were also included in the discussions. This group decided on a limited number of technologies, including types of equipment provided through the ALDEP program, that were to be presented for testing. Logistical details were also arranged.

Just prior to the normal beginning of the cropping season, the AD asked the village headman to call a traditional village meeting at which he and the ATIP Francistown staff described the farmer group work in other villages and invited interested farmers to attend the initial group meeting to be held two weeks later. At the initial group meeting, the AD and ATTP staff discussed the technologies available for testing and how tests were to be conducted. Farmers were asked to indicate in which tests they wished to participate.

At subsequent monthly meetings, the implementation of trials was discussed. The farmers were asked to decide on their own how large to make the test plots and to stake the plots accordingly. While side-by-side comparisons were recommended, many trials were implemented without a comparison and so became demonstrations rather than true trials. A field assistant was hired to assist the AD in working with farmers to collect data, provide seeds and equipment, etc.

Monthly meetings to discuss trials were held. Farmers described their observations on the trial to the group. The farmer group meetings were chaired by the AD. All meetings were attended by ATIP and district-level extension staff. ATIP and extension staff visited all trials at least once during the season.

A field day was held near the end of the season. Farmers from other villages, extension staff (including the Director of Field Services) and research staff all participated

Following harvest the ATIP staff is currently conducting a formal end-of-season survey of participating farmers to obtain farmer assessment of the trials they participated in and the group activities. This information will be included with extension and researcher evaluations of the group activity in a progress report.

Training, Staff Commitment and Logistics

The DAO and AD had the most time committed to this group. The AD needed training in group management and also in some of the technologies, particularly some of the equipment. This was provided by the ATIP staff on an informal basis. The field assistant hired to work with the AD did not receive any training and so did not perform well Better training is needed for both the AD and the field assistant.

ATIP staff attended farmer group meetings and made field visits. Some equipment, seeds, etc. were provided by ATIP. Other equipment came from the extension program.

Limitations

In addition to some of the limitations listed for researcher-managed groups, the extension-managed group has some unique limitations:

a) Because of the limited time available for the AD to work with the group, and because of an untrained field assistant, the level of support to group members was low, and many trials were not implemented or were poorly implemented. This is partly a function of the extension staffs learning how to work with groups in an options-testing situation.
b) The approach is limited in that it does take AD time, a commodity in short supply because of other demands. There is also the risk of heightened farmer expectations, many of which will not be met.

Other limitations probably will be identified when the season's experiences are analyzed.

CONCLUDING COMMENTS

The ATIP approach to farmer involvement in farming systems research is to attempt to integrate fanner participation into the research/extension establishment through the use of farmer testing groups to facilitate FMFI trials. The use of farmer testing groups has a number of advantages for the researchers and the extension agent.

a) The researcher has limited time for conducting researcher-managed trials, and the FMFI trials conducted through the group format can expand the number of technologies being examined.
b) The extension agent also has great demands on his/her time for administering drought relief and other government programs. With limited time to devote to extension of technologies, the best use of the time is to work with groups of farmers. Farmers testing the technologies are more involved than in traditional extension demonstration plots and are in fact testing the recommended technologies for acceptability under local conditions.
c) The communication and discussion among farmers, extensionists and researchers are increased. This an area in which farmers make a major input into technology evaluation and evolution. Farmers, through their choices of trials, also provide valuable information on what technologies are of interest to them. Research and extension staff receives early and continuing feedback and technologies.
d) The inclusion of extension personnel in the research process means they have a chance to suggest modifications during the trials and also become familiar with new technologies they will later extend

e) There are a number of advantages to joint farmer/research/extension Meld days. First, there is a great deal of interest when farmers describe their experiences and conclusions to other farmers. Second, inter-village competition can develop, lending an incentive to try new technologies. Third, extensionists and researchers can get added information as farmers tend to ask more questions of other farmers than they do of researchers. Finally, the use of side-by-side comparisons facilitates discussion.

A number of problems encountered while working with farmer testing groups have been discussed above. Several additional issues can be raised.

a) To date statistical analysis of data collected on farmer trials has been minimal because of the small amount of hard data collected. The limited amount of data that can reasonably be collected from fanner groups is one reason that farmer group work must be part of a larger research program—so that questions needing more intensive analysis can be handled by researcher-managed trials. The development of assessment tools and ways of collecting more statistically analyzable data from the farmer group trials are important methodological concerns. The ability to generate hard data is important in legitimizing conclusions based on fanner trials within the research establishment
b) The questions of determining an optimum size group and keeping the group to that size are problems that remain. There is a need for group continuity, but it is also desirable to have new farmers participate in the groups as they bring new ideas and involve a larger number of farmers in the development process.
c) For many of the problems raised in group discussions there may be no identifiable solution that is technically and sodo-economically viable. This lack of implementable solutions can be frustrating for all parties concerned.

Nonetheless, farmer reaction to the farmer testing groups has been quite positive, and the approach has been beneficial in focusing research on farmer-identified problems.

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TABLE 1: Typology of farmer groups.

Characteristic	Design	Focused testing	Researcher-managed options testing	Extension-managed options testing
Objectives	Farmer involvement in technology design	Discuss farmer's own problems. Measure economic benefits Farmer assessment.	Increased farmer and extension involvement. Large scale assessment	Local farmer and extension testing for local adapt-ability & demonstration purpose.
Number of trial types	1 to 3	4 to 6	10 to 12	4 to 6
Trial: proposal	Researcher	Researcher	Researcher/ Extention	Extension/ Res.
selection	Researcher	Researcher/Farmer	Farmer	Farmer
management	Researcher	Farmer	Farmer	Farmer
implementation	Researcher/farmer	Farmer	Farmer	Farmer
Quantitative measurement[1]	Most	Middle	Least	Minimal
Assessment: researcher	Most	Middle	Least	Minimal
farmer	Least	Middle	Most	Most
Group: size	2-3 farmers	10-15 farmers	25-40 farmers	25-35 farmers
nature	Homogeneous	Homogeneous	Heterogeneous	Heterogeneous
selection	Technical situation appropriate for design work.	Socio-economic situation for targeted technology.	Volunteers from village meeting.	Volunteers from village meeting.
Frequency of meeting	2-3 times a season	Monthly in season	Monthly in season	Monthly in season

[1] Relative to the other types of groups.
Modified from: Norman et al., 1988.

Table 2. Technology options explained to farmers' groups and offered as option for testing, Francistown area, 1986-87.

Technology	Uses	Conditions for applications (and timing)	Resources and inputs required (labor, cash)
SUBJECT: WATER CONSERVATION			
A) Double ploughing	Reduce runoff & erosion, conserve water.	Preliminary tillage to be done a) on very early season rains b) on dryer periods between rains. NB: Not to be done after mid Jan; use dry-planting instead.	Non-restricted access to draught power. Will increase ploughing labor and draught use where animal draught only is used.
B) Contour ploughing	Reduce runoff & erosion. Conserve water.	Field contours should be marked before onset of rains.	Nothing extra (contouring done free by SCS (GOB).
C) Contour strip double ploughing	Concentrate water. Reduce runoff & erosion, increase soil porosity.	Field contours marked before onset of rains	Extra weeding between strips.
SUBJECT: CROP MIXTURES			
A) Short season crops & varieties: Cowpeas ER7 (60-70 day) Millet Serere 6A (7540) Sorghum 8D (85-90) Sorghum 65D (70-80)	Reduce risk of total crop failure due to early termination of rain.	Suggested mixes thru season: 1) Before Dec 1: 75%LS, 25%SS[1] 2) Dec 1-Jan 15: 50%LS, 50% SS 3) Jan 15 on: 25%LS, 75%SS	Labor available for harvesting, drying from early March onwards. Purchase seed? Bird scaring may be necessary earlier than usual
B) Annual forage crops	Provide supplemental dry season feed of good quality	Livestock needs (eg. early feeding of draught animals, fattening for sale, milk production).	Planting labor in Feb., weeding in March. Seeds (free from ALDEP). Harvest May-June.
SUBJECT: PLANTING METHODS			
A) Broadcast (traditional)	Buffered planting system for non-optimal soil moisture condition	Anytime, especially for farmers without planting equipment or planting on non-optimal soil water.	None extra (plough, animals, labor)
B) Broadcast (Hurricane seeder)	Same as above. More even seed dist. Decrease with-in-field plant stand variation.	Farmer interest	Hurricane seeder, no extra labor
C) Hand row planter	Plough on poor soil water, plant on good moisture (For farmers without draught-ensures good plant stand.	Anytime, but only on good moisture or completely dry soils. Good soil preparation required.	Well-tilled seed bed. Sanitas hand row planter or Master planter. Extra labor at planting.
D) Sebele row planter	Ensure good plant stand.	Requires good soil water condition for effective use. Also requires understanding of mechanics. Use anytime before Jan 15 (plough/plant same time thereafter). Well-trained draught power.	Sebele row planter. Planting labor. Well-trained draught power.
E) Improved harnesses, yokes and animal care. Proper plough adjustment	Improve efficiency of ploughing operations, improved animal well being.	Throughout ploughing operations.	Improved equipment. Knowledge of animal husbandry (rudimentary). Cost of equipment.

continued

Table 2 continued.

Technology	Uses	Conditions for applications (and timing)	Resources and inputs required (labor, cash)
SUBJECT: WEEDING			
A) Inter-row weeder (modified Indian design)	Reduce weeding time; increase timeliness of weeding.	Row planting situation	Donkeys, weeder
SUBJECT: FORAGES			
A) Annual forages Babala millet and Lablab	Provide supputai dry season feed of good quality for early feeding of draught animals, stall feeding, supple-feeding selected livestock.	Anytime but only on good moisture or completely dry soils. Good soil preparation required.	Well-tilled seed bed. Broadcast and plough down or use Sebele row planter. March weeding? May-June harvesting.
B) Perennial forages Buffel grass and Siratro		Land available for permanent pasture. Seed before Feb. 15. Good soil preparation required.	Broadcast on well-tilled seed bed, cover with brush harrow. Seeds (free from ALDEP).
SUBJECT: STALL FEEDING			
A) Fattening market animals for sale in Oct-Dec	Marketing crop residues through livestock.	Animals available for feeding. Feed for approx. 100 days from July-Aug to Oct-Dec Access to good market	Stall for feeding built with local materials. Purchased maize bran, salt and bonemeal. Use spare labor during dry season.
B) Chemical fertilizer	Increase soil fertility	Use P on all soils, use N on poor soils under higher rain-fall conditions.	Transport for fertilizer to field, labor for broadcasting and cash to buy fertilizer.

[1]LS = long season;
SS = short season.

THE VALUE OF FARM FAMILY LABOR IN MAIZE-BASED CROPPING SYSTEMS IN THE NDOP PLAIN IN THE NORTH WEST PROVINCE OF CAMEROON

Dermot McHugh[1]

INTRODUCTION

Testing and Liaison Unit

The Testing and Liaison Unit (TLU) is a fanning systems research and pre-extension component of the Cameroon National Cereals Research and Extension (NCRE) Project, responsible for carrying out farmer surveys and on-farm experiments and ultimately generating farmer recommendations. Four TLU's have thus far been established in Cameroon, with regional responsibilities for the northern savannah, central-south forest, coastal forest and mid-altitude zones, respectively.

The original TLU at Bambui has been working in the western highlands since 1981. By the end of the first phase of the NCRE project, the TLU had tested and identified new maize varieties adapted to farming systems in many of the sub-zones (recommendation domains) in the region and defined fertilizer recommendations suitable for the commonly found maize/groundnuts and maize/beans intercrops.

In 1987, the TLU-Bambui carried out a year-long farm monitoring survey of maize-based cropping systems in the Ndop Plain of the North West Province of Cameroon. Beyond a detailed description of the cropping patterns and cultural practices, measurements of crop yields and recording of farm sales, extensive data were collected on labor utilization.

Maize

Maize *(Zea mays,* L.) is the most important cereal crop in Cameroon and the staple food crop in the western highlands (North West and West Provinces), where more than 70% of the maize in Cameroon (total annual production = 500,000 tonnes) is grown (Ayuktakem, 1981). The most common use of maize is in "corn fufu," a starchy paste eaten with vegetables or a sauce. Other uses include "corn chaff' (fried maize and beans), corn beer, "corn korky" (a type of maize pudding, often made with dried fish) and limited use as animal feed.

Almost without exception, maize is intercropped with other food crops (grain legumes and root crops), and not infrequently with cash crops (coffee). It is typically grown in scattered small fields (under 1 ha) and on ridges, using intensive manual labor. In a yield-cut survey in 1983, MIDENO[2] estimated mean maize grain yields for the North West Province at 1.8 tonnes/ha.

Originally a subsistence crop, maize has assumed an increasingly important role as a supplementary cash crop, with excess production sold piece-meal over the course of the year to meet small cash expenditure needs such as school fees and health care costs. With this latter development, men are showing more interest in maize cultivation, which traditionally had been strictly a woman's occupation.

Labor

In manual food crop production systems characteristic of most developing countries, labor dominates production costs (as much as 80% of total costs). However, it is difficult to quantify, if not qualify, labor utilization in such systems. A number of approaches have been proposed and used, each having its advantages and draw-backs. Generally, the more accurate the method, the costlier it is.

Ideally, the farmer can be timed in an unobtrusive manner while carrying out operations on the farm. But this system is too costly. Researchers have turned to methods dependent on farmer recall (Ay et al., 1986). Another method entailing random "spot checks" of farmers' activities was used by Conelly et al. (1987) to estimate household labor allocation in mixed farming systems in Kenya. Alternatively, a low-cost method, using farmer comparisons of the relative labor requirements of a target crop with those of two crops of known labor

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[2] North West Development Authority, an integrated rural development project, funded in part by IFAD.

requirements, was described by Knipscheer (1981). In the present study, farmers were interviewed daily upon their return from the fields in the evening using standard questionnaires. The objectives of the larger study, pertinent to this paper, include:

- measuring total labor utilization in maize-based cropping systems, by operation and by labor class;
- measuring weekly labor distribution throughout the year with an eye to identifying potential labor bottlenecks;
- measuring total utilization, seasonal distribution and cost of hired labor; and,
- estimating gross returns, production costs and net returns to farm family labor from the maize-based cropping system.

MATERIALS AND METHODS

Twenty-four farmers were randomly selected from six of the 13 villages in the Ndop Plain. A resident enumerator was recruited in each village and charged with collecting data on labor utilization; crop production and farm produce sales from the monitored farms in addition to recording weekly food crop commodity prices in the village market.

One maize field per farm (the "monitored field") was chosen for detailed data collection. The monitored field was measured; soil and maize plant tissue samples collected for analysis; and cropping pattern (crops, densities and planting configurations) were noted. The farmer was interviewed at length about the cropping history and cultural practices of the monitored field.

Labor data were obtained during daily interviews of the four selected farmers in each village by the enumerator, using a questionnaire. Every evening, the farmer was asked what farm operations were carried out during the day, by whom, in which fields, the time started, the time finished and the amount of intervening time not worked (resting, eating, etc). Any harvested produce from the monitored maize field was weighed and any sales from the farm that day recorded. The considerable data generated (720 "daily labor input report forms" per month, plus "harvest yield forms" and "produce marketing forms") were processed at the end of each month using a computer spread sheet (LOTUS 1-2-3).

RESEARCH SITE

The Ndop Plain is a fertile valley, lying between 1150 and 1300 m above sea level (masl), most of which is included within the Ndop Subdivision in the Mezam Division of the North West Province of Cameroon (Fig. 1). The Plain covers an area of 1,117 km^2 with population density of almost 100 inhabitants/km^2 (110,000 total population). The dominant ethnic group is Tikari (80%) (SEDA, 1983).

The 13 villages in the Plain, each having between 10 and 15 subquarters, are small kingdoms ruled by a "Fon" and a "traditional council." Land is attributed to families and is clearly demarcated. Free land or land of families without heirs is owned by the Fon. The Fon and traditional council can take land from a family for community use (school, water project, etc.) and compensate the family with other land. Land can be sold by the head of family with the consent of the traditional council. Pasture land belongs to the Fon, who arranges with transhumant Fulani herdsmen for use of the pasture during the dry season, sometimes to the detriment of his farming subjects (SEDA, 1983).

Eighty-five percent of the cultivated land is in food crops. The mean farm size is 1.5 ha, and the average family has six members, with three active in agriculture. Maize, the principle food crop, is almost universally intercropped with groundnuts, cocoyams and/or beans (SEDA, 1983). The traditional cash crop (arábica coffee) has been somewhat superseded by rice since the mid 1970s, encouraged by the establishment of the rice-growing corporation UNVDA (Upper Noun Valley Development Authority) (Samatana et al., 1986).

Annual rainfall varies between 1100 and 1800 mm, and temperatures range from 20 to 35 C.

RESULTS AND DISCUSSION

Farm Family

The monitored farm families had an average of eight members. Most households were monogamous (mean of 1.3 wives). Four households were lacking husbands (one unmarried woman, two living separately and one deceased), indicating a possible bias in the estimate of the labor share of men. However, assuming the survey sample is representative of households in the Ndop Plain, the estimates will reflect the true relative labor contribution of men throughout the zone. The mean age for the monitored farmers, was 41 years, and mean education was 1.2 years (primary school).

Available weekly family labor per household was computed as follows:

adults (15 years and above): 40 man-hours/week
children: 20 working-hours/week x 0.5 man-hour/working-hour = 10 man-hours/week

Accordingly, the mean available family labor per monitored farm household was 183 man-hours/week.

Other Sources of Labor

Besides family labor, farmers in Ndop plain, as in most of the North West Province, depend on farmers' cooperative labor groups (67% of monitored farmers) and hired labor (88%). Farmer work groups vary in size from 2 to 20. They are usually comprised of women, although there are some men's farming groups. They are never mixed.

Labor Distribution by Farm Operation

There are seven major field operations for maize-based cropping systems: land clearing, land preparation, planting, weeding, fertilizer application, harvesting and transporting (Table 1). There are a few minor operations (in the sense that few farmers do them) that are classified under "other operations." These include such activities as thinning of maize, earthling up of maize (usually combined with weeding), pruning of coffee in the few maize fields with coffee, etc.

Because of the manner in which they are carried out in the Ndop Plain, it was impossible to separate land preparation labor from planting labor, or harvesting labor from labor for transporting of produce from the farm. Therefore, for purposes of labor-use data collection, production was divided into six operations.

1. Land clearing;
2. Land preparation (tilling/ridge making) and Planting;
3. Weeding;
4. Fertilizer application;
5. Harvesting and Transporting; and,
6. Other operations.

The average distance from the house to the monitored field was 2.2 km (measured). The labor estimates for field operations do not include traveling (walking) to and from the field with the exception of transporting produce from the farm, which is included in harvest labor.

Because of a certain amount of flexibility in carrying out field operations (more for some than for others), individual farmers will not necessarily be performing the same operation during the same week. For example, one farmer may weed her maize field in week 1 and not work in the field in week 2 while a second farmer is working in other fields in week 1 and weeding the maize field in week 2. The mean weeding labor estimate for the two farmers will show that the "average farmer" spreads the weeding labor over two weeks. Thus, mean estimates tend to smooth out the weekly labor trend and are not necessarily descriptive of how individual farmers actually schedule their labor. Nevertheless, the weekly means are indicative of the general timing of operations and a good estimate of total labor requirement for each operation.

Land Clearing

Most of the monitored fields had been cropped in the preceding year. Therefore, land clearing entailed cutting of crop residues and standing weeds (mainly grasses). In some cases, clearing was done before data

collection commenced (i.e., before 9 February). For others, the residues were few enough to be removed and/or incorporated by hoe during the tilling operation. For the latter, land clearing labor could not be separated from land preparation labor.

To obtain a better estimate of the land clearing labor requirement, a reduced sample (n = 17) was used, omitting those farmers for which there was no reported land clearing labor (either carried out before reporting began, or indistinguishable from land preparation).

Most farmers cleared the land between February and March. The mean labor input was 207 man-hours/ha (median = 203). (In a skewed distribution, the median value sometimes serves as a better estimate of the population mean than the sample mean. Therefore, both mean and median estimates will be given in all cases).

Wives contributed most of the labor (45%) for land clearing, followed by the husband (25%), children (15%) and other (adult) household members (12%). This is not a typical farming group operation (1%). And few fanners hired labor (2%) to clear their maize farms.

Within limits, the land clearing operation can be assumed to be cropping system independent. The primary determinants of the labor requirement are composition of the labor force; type and quantity of vegetation to be cleared (trees, brush, herbaceous weeds and crop residues); topography; and weather. What is to be grown on the cleared field has little or no effect on the land clearing operation. Therefore, these labor estimates can be broadly applied across varying cropping systems, at least within the same zone.

Land Preparation and Planting

By land preparation is meant tillage of the soil and preparation of the seedbed. The soil is arranged in ridges on which the crops are planted. This is done with the aid of a short-handled hoe with a large rounded blade ("country hoe").

In the Ndop Plain, many, if not most, farmers plant their crops as they make the ridges. The farmer will prepare one or two ridges and then plant them before continuing with ridge making. For this reason, and because of the data collection method, it was impossible to separate labor inputs for land preparation and planting Therefore, the two operations are treated as one.

Land preparation and planting is the most labor intensive operation of all (mean = 659 man-hours/ha; median = 548). It begins as early as mid-February and can continue as late as mid-April. There is also some land preparation for the late bean crop (planted in September or October). The reason given by farmers for not preparing the land earlier to avoid a labor bottleneck during planting (say January, as is done in the highland zone in Bui Division) is that the soil is too hard to work before the first rain falls (Tame et al., 1987).

The largest share of the labor input for land preparation and planting is, again, by wives (49%) followed by the husband (18%), children (11%) and hired labor (11%). This is the peak period of labor use during the year for the maize-based cropping system (Fig. 2). That is why hired labor is used more for land preparation than for any other operation. Farmer groups (4%) also play a more important role in tilling and planting than at other times of year.

Weeding

Weeding of the maize crop is done twice during the season, on average. It is done by hand and hoe and is usually combined with earthing up of the maize (i.e., pulling soil up around the base of the maize stalk to provide better support against lodging).

The normal timing of the first weeding is in mid to late April, one month after planting. However, because of an extended dry period in April, weed (and crop) growth was retarded, and the first weeding by most farmers delayed until May. The mean total labor requirement for weeding was 513 man-hours/ha (median = 502). Although weeding has a relatively high labor requirement, flexibility of timing, plus the fact that weeding is commonly done twice, permits farmers to spread out the labor to avoid constraining peaks.

Once more, the labor share for wives was dominant (55%). However, this time children were second (15%),
followed by the husband (14%) and other household members (8%). Weeding, along with land preparation and planting, was the activity most commonly carried out by cooperative farming groups (4% of weeding labor). Hired labor (4%) was used less than in the preceding operation but is still important.

Fertilizer Application

Only seven (29%) of the monitored farmers applied fertilizer to the maize on their monitored field. Typically, either 20-10-10 compound fertilizer or ammonium sulfate (21% N) is applied at the base of the maize stands after the first weeding in late April or early May. However, because of the drought and the delayed first

weeding, fanners didn't apply the fertilizer until the maize had fully recovered in late May, one month later than normal.

The fertilizer applied by the seven farmers gave an average rate of 56 kg/ha of nitrogen (N) and 23 kg/ha each of phosphorus (P_2O_5) and potassium (K_2O).

Mean labor utilization for fertilizer application was 24 man-hours/ha (median = 20). Wives (46%) and children (54%) applied the fertilizer.

Harvest and Transporting

With the exception of a few ears that are picked green for roasting, most of the maize is harvested dry (at between 20 and 40% grain moisture content). The maize is ready for harvest anywhere from the end of July to the beginning of September, depending on the maize variety, the date of planting and the climatic conditions. Groundnuts are harvested just after maize in the Ndop Plain. First season beans are ready in June, and late season beans are harvested in November or December. Cocoyams are harvested September to March.

Total harvest and transporting labor (from the field to the house) is less than total weeding labor (mean = 342 manhours/ha, median = 284). But because of less flexibility in timing, the labor peak was more pronounced.
(Fig. 2). The maize is harvested during the height of the rainy season, when it is particularly vulnerable to lodging and ear rot. In addition, when the harvest is unduly delayed, there are mounting risks of damage by animals and birds and theft of the maize in the field. This leaves a relatively narrow window within which the harvest must be completed (within 2 to 4 weeks of maturity).

Wives continue to dominate the labor share (44%). Children are home from school (holidays) and also play a important role in harvesting the maize and groundnuts (27%). Wives and children, thus, account for nearly three quarters of the total harvest labor between them.

Total Labor for the Maize-Based Cropping System

In addition to the above operations, an average of 93 man-hours/ha (median = 118) was spent on "other operations," mentioned previously. Mean total labor utilization for the maize-based cropping system (monitored field) was 1838 man-hours/ha (median = 1675) (Fig. 2).

Labor peaks occurred in February (land clearing), March (land preparation and planting), May (first weeding) and August (harvest). The biggest peak was at the end of March, when mean weekly labor use surpassed 110 man-hours/ha. As mentioned before, mean weekly estimates tend to spread the labor distribution, smoothing out the weekly labor peaks. For individual farmers, the peaks are usually higher and more condensed in time (Fig 3).

The distribution of maize-based cropping system labor utilization, by field operation, is shown in Fig. 4. The most labor intensive operation is land preparation & planting (36%) followed in order by weeding (28%), harvesting and transporting (19%) and land clearing (11%). Fertilizer application and "other operations" combined account for only 6% of total labor use.

Total labor distribution by labor class, as presented in Fig. 5, shows that wives contributed over 48% of the labor. Children were second with 18% and the husband third at 16%. The farm household provided 91% of the overall labor input for the maize-based crapping system.

Hired Labor

Hired labor is paid for in cash before or shortly after the work is done. The mean total paid (for all crops) was 20, 341 CFA, equal to 16% of mean total crop sales from the farm. It is an important cost for the farmer, and its distribution over time is a critical component in the cash flow for the farm.

Mean total use of hired labor (whole farm) was 114 man hours (102 man-hours/ha for the maize-based cropping system), with the highest use in August (27 man-hours) when maize harvest coincided with rice transplanting (Table 2). Fifty-one percent of total hired labor was used during three months (July-Sept). Another 21% was hired in March and April for land preparation. Twenty-one of the 24 monitored farmers (88%) hired laborers at least once during the year. On a monthly basis, and excluding February for which only 2 weeks' data were available, the proportion of farmers hiring labor varied from 21% in May to 46% in August, October and November.

Returns to Farm Family Labor

An enterprise budget for the maize-based cropping system is presented in Table 3. Total benefits are calculated using mean crop yields for the monitored fields and market prices at the time of harvest. Fertilizer

costs were based on the mean quantity of fertilizer used on the monitored Gelds and fertilizer prices paid to coffee cooperatives in the Plain. Seed quantities were made proportionate to mean planting densities, and the prices used were those in the village markets at planting time (March). Hired labor costs were estimated using the mean wage rate of 206 CFA/man-hour. Interest on capital investment was put at the credit union rate of 1% per month times 6 months, or 6%.

Total net benefit is 68,068 CFA/ha. It represents a net return to farm family labor and land.

Labor contributed by farming groups is reciprocated by farm family members working an identical number of hours on the farms of other group members. Therefore, farming group labor only borrowed labor, and effective farm family labor can be calculated by deducting hired labor from total labor (1838 - 102 = 1724 man-hours/ha).

The net return to farm family labor was computed by dividing total net benefit by the number of man-hours worked by the family (39 francs CFA per man-hour).

Note

On-farm trials in the Ndop Plain (IRA, 1982 - 87) have shown that by simply planting an improved open-pollinated variety (such as COCA or Kasai- I) at a higher density (40,000 plants/ha) and applying a moderate rate of fertilizer (N = 50 & P = 25), maize yields can be increased by at least 50%. At the same time, groundnut yields will be depressed by the shading of the maize (20% reduction).

Even assuming that there are no other crops planted on the field, total benefit would increase by 21%. And despite a 14% rise in variable costs, total net benefit is increased by 25%. This would give a net return to farm family labor of 49 CFA/man-hour.

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Table 1: Mean labor utilization (man-hours/ha) for maize-baaed cropping systems, by operation, by labor class (Ndop Plain, 1987).

Labor Class	Farm Operation					
	Land Clearing	Till & & Plant	Weeding	Fert. Applic.	Harvest & Transport	All
	man-hours/ha					
Husband	52	120	73	-	49	299
Wife (ves)	92	320	284	11	151	889
Children[1]	32	74	77	13	92	334
Other household	25	43	39	-	30	153
Farmer Group	2	28	22	-	10	61
Hired	4	74	18	-	10	102
Total	207	659	513	24	342	1838

[1]Under 15 years.

Table 2. Mean monthly hired labor utilization (man-hrs), wage rates (fCFA/hr) and proportion of farmers (%) using hired labor on the monitored farms.

Month	Mean Total Hired Labor Utilization	Mean Wage	% of Farmers using Hired Labor
	man-hours	fCFA/hr	%
February '87	1	265	8
March	10	326	29
April	12	189	25
May	7	195	21
June	6	261	25
July	13	200	33
August	27	100	46
September	14	204	33
October	7	200	46
November	4	182	46
December	6	185	38
January '88	7	165	42
Total	114	-	-
Mean	10	206	33
SE	2	16	3
Median	7	198	33

Table 3: Enterprise budget for the maize-based cropping system.

Item	
Mean crop yields:	(kg/ha)
Maize	1973
Groundnuts	53
Beans	39
Cocoyams	77
Benefits:	(CFA/ha)
Maize	72,999
Groundnuts	21,050
Beans	7,036
Cocoyams	3,402
Total Benefit	104,487
Costs:	(CFA/ha)
Seed	9,350
Maize (15 kg)	1,050
Groundnuts (10 kg)	5,000
Beans (5 kg)	800
Cocoyam (50 kg)	2,500
Fertilizer	3,996
20-10-10 (73.2[1] kg)	3,294
Ammonium-sulfate (15.6 kg)	702
Hired labor (102 man-hours)	21,012
Interest on capital (6%[2])	2,061
Total Cost	36,419
Total Net benefit	68,068 (CFA/Ha)
Net return per man-hour of family labor	39 CFA/man-hour

[1] mean per farmer = (230 kg/ha x 7 farmers using fert) / 22 farmers
[2] Credit union rate (12% p.a.) for 6 months.

Fig. 1. Map of Northwest Province, United Republic of Cameroon.

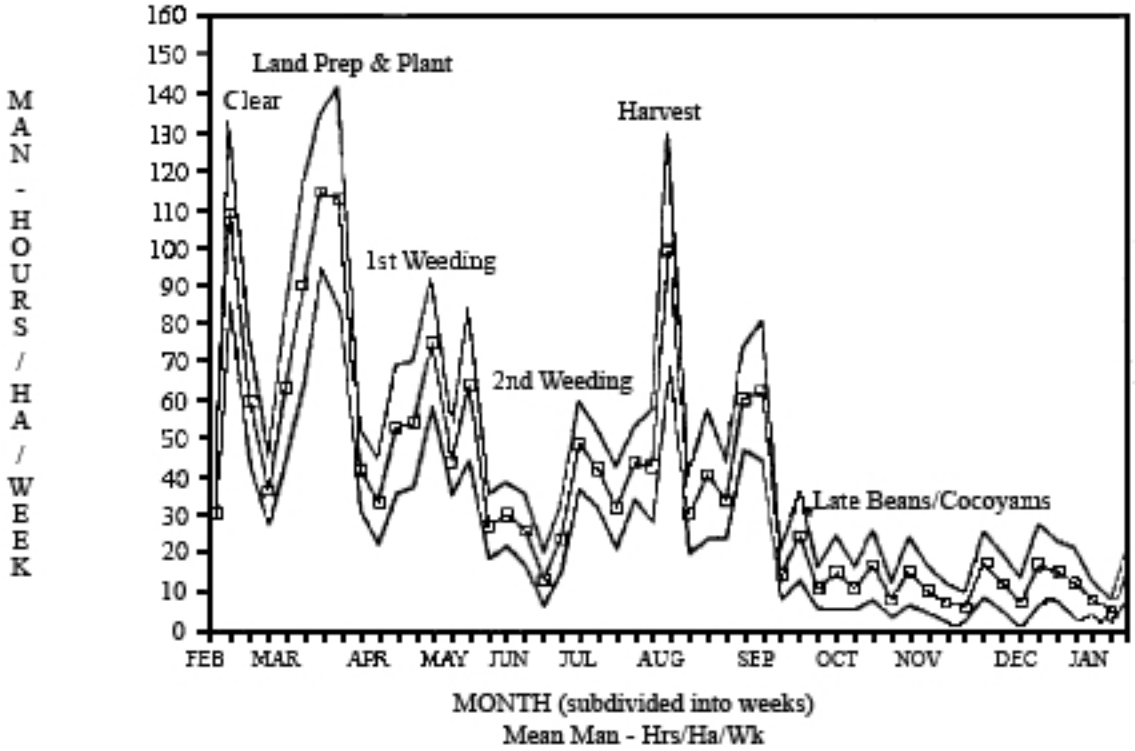

Fig. 2. Mean total weekly labor (monitored field, + / - one standard error).

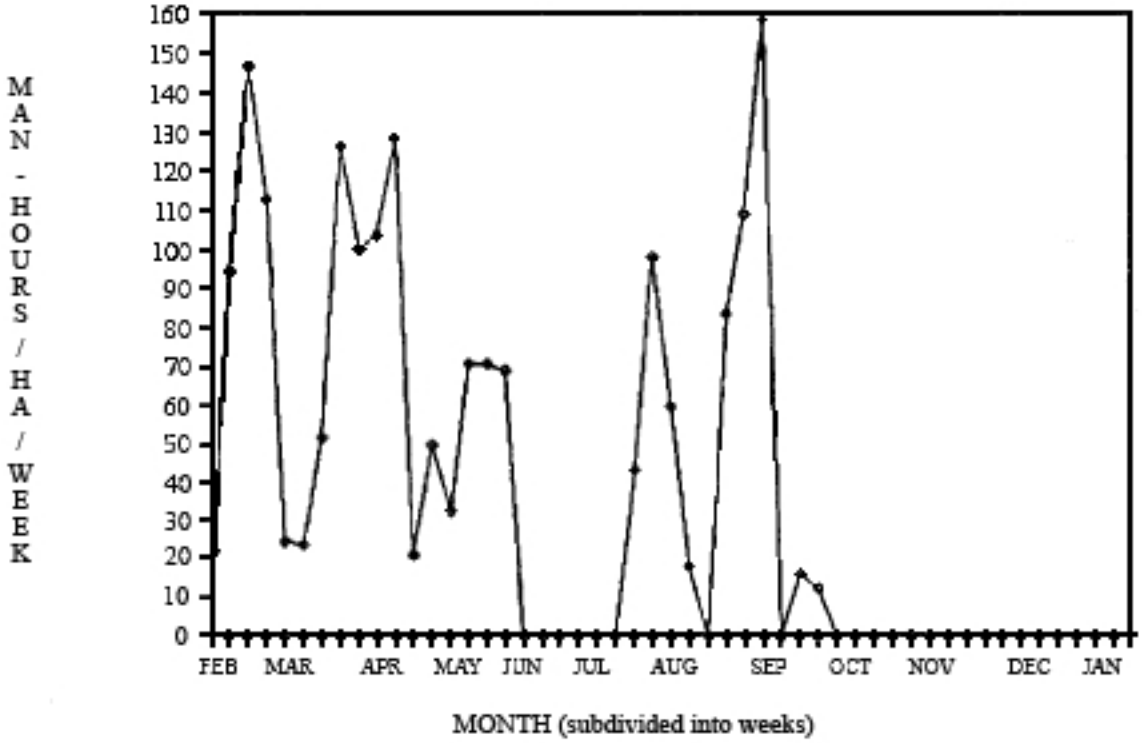

Fig. 3. Weekly labor for an individual farmer (total annual labor = 1848 man-hours).

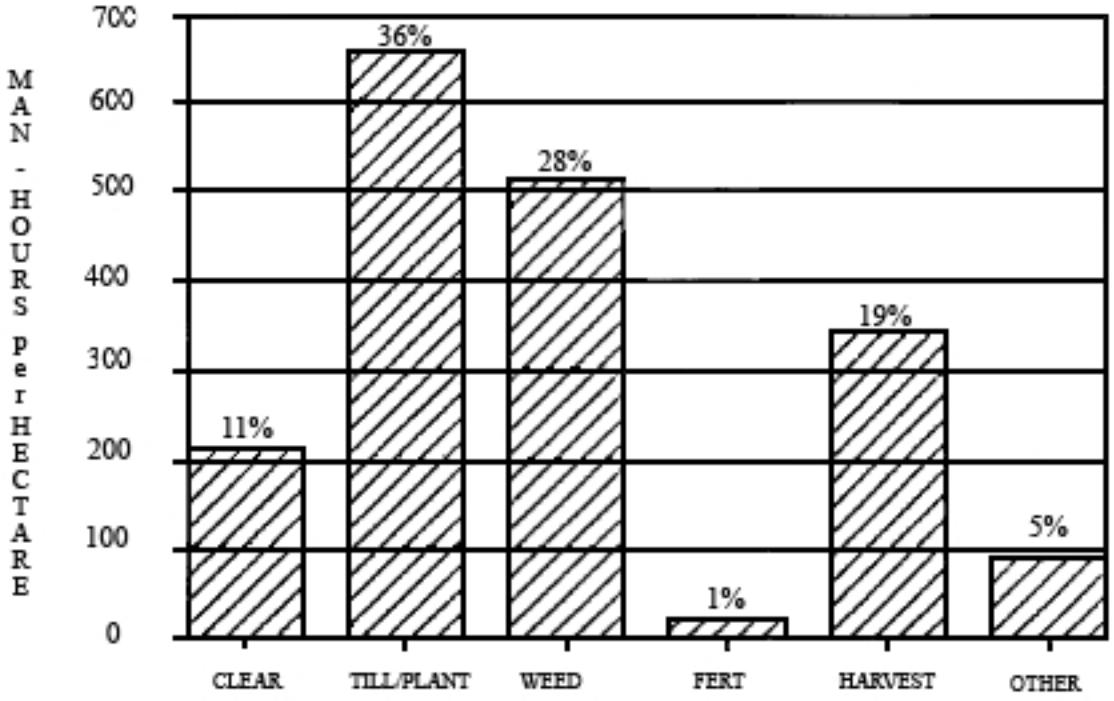

Fig. 4. Labor utilization by farm operation (mean total = 1838 man-hours/ha).

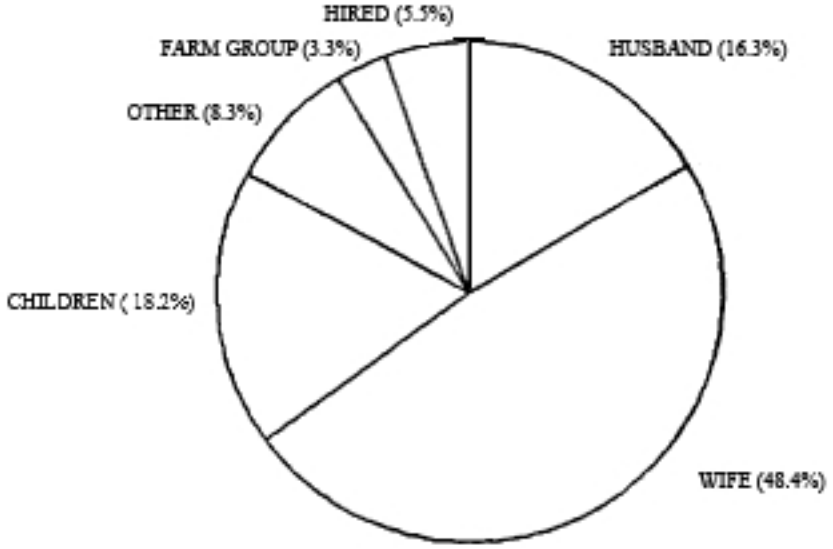

Fig. 5. Distribution of monitored field labor (by labor class).

Asian Regional Papers

REGIONAL SESSION: ASIA/NEAR EAST
A SYNTHESIS OF PRESENTATION AND DISCUSSIONS

Randolph Barker, Clive Lightfoot, Nimal Ranaweera,
John Caldwell, David Gibbon and Patrick Ludgate

INTRODUCTION

The Asia/Near East group focused on the following themes: (1) impact evaluation, (2) farmer-led experimentation and (3) extension linkages. The session included three two-hour periods, each dealing with one of the three themes. Papers were presented during the first hour of each period. The 60 participants were then divided into four discussion groups headed by a facilitator. Facilitators and rapporteurs met to identify the key issues to be included in this synthesis report.

IMPACT EVALUATIONS

The question was raised in one of the discussions whether impact evaluation is really necessary. The general consensus of the group was definitely yes. Those who finance FSR activities want evidence to justify the continuation of their support However, evaluation of impact is needed not simply for the benefit of funding agencies, but as a planning device for those implementing the project A well-conducted evaluation can serve as a guide to reorientation of the research effort, can identify the need for support services and/or policy measures to facilitate the extension of technology and can identify the need for organizational or institutional changes to strengthen researcher-extension-farmer interaction.

How does one choose the criteria for evaluation of FSR/E programs or projects? Any project must be evaluated in terms of the degree of success in achieving stated goals and objectives. Surprisingly, objectives and criteria for implementation are often not stated clearly but are implicitly assumed.

The objectives of most FSR/E projects include the following: development of sustainable farming systems, greater participation of farmers in the research process, extension of benefits to resource-poor farmers and institutionalization of FSR/E extension at national or regional levels as a part of the research/extension process.

Determining whether a project has contributed to increasing the income or welfare of the target group is often very difficult for a number of reasons. For example, the impact of the project is often realized only gradually over a long period of time. It is difficult to separate out the impact due to the project from other factors such as changes in weather, prices, policy or criteria for implementation. However, it is possible to judge whether the project is "on the right track" not simply by looking for quantitative impacts such as increases in yield or income, but also by looking for qualitative changes and by evaluating research processes and procedures. Thus, we should distinguish between product and process impact.

Product impact evaluation

Product impact evaluation should address questions such as the following:

1) Has the goal of improved well being been achieved through increased production?
2) How have the benefits of research been shared among the community?
3) How has innovation affected the sustainability and stability of the farming system?

Process impact evaluation

Process impact evaluation should address questions such as the following:

1) Does research take a holistic look at systems interactions among trees, crops and livestock?
2) How do farmers participate in the FSR/E process?
3) What is the feedback effect of FSR/E on experiment station research, on agricultural policy?
4) How has FSR/E been institutionalized within the national research/extension system (whether it be government, university or private)?

Too little attention has been given in most FSR/E projects to the development of appropriate procedures and methodologies for evaluation. Evaluation procedures must be planned at the beginning of the project to insure that adequate data are collected. Benchmark surveys are frequently maligned because the large quantity of data results in time-consuming analysis. However, a short and simple benchmark survey conducted at the beginning of the project and designed as an evaluation tool can be useful. It normally would be inadvisable, for example, to attempt to determine farmer income. However, selected measures of or questions on production, farmer practices, input levels and consumption (e.g., housing, schooling, food consumption), if asked initially and at periodic intervals, can provide a solid foundation for impact evaluation.

The evaluation process must be continuous, reflecting the dynamic and interactive process of FSR/E. There should be a mixture of external and internal reviews.

Research donors and policy makers typically think of impact evaluation in terms of "tangible" numbers such as percentage of adopters, increase in yield of adopters or increase in income of adopters. However, there was a general consensus that focusing on adopters and non-adopters could be extremely misleading. In fact, the definition of "adopter" is often very arbitrary. The impact of change must be examined over time and space, not focusing only on those households that adopt the technology, but examining all households in the study area. For example, a new technology may benefit non-adopting households through impact on employment. The impact of FSR/E should be examined in terms of both relative and absolute changes in welfare among households or communities.

FARMER-LED EXPERIMENTS

The group reiterated many of the same problems in conducting on-farm experiments that were expressed last year. Over ambitious research programs for the staff, transport and money availability and poor communication with farmers continue to plague projects with unanalyzable data.

Overworked teams invariably compromise on research quality. Thus field trials are often established incorrectly or late. Logistical problems, notably in procurement of seed and fertilizer, only add to the list of reasons for poorly implemented trials. Outright crop failures, changes in weather and dissimilar farmer management practices make it very difficult to get reliable data. A further source of variation arises from misunderstanding between fanners and researchers. Examples of inadequate farmer participation include farmers that do not complete the operations they said they would or farmers that do not follow instructions, for example harvesting all treatments one week early.

From the statistical viewpoint, it is often fruitless to apply standard predictive tests to such variable data. The inadequacy of conventional statistical procedures to deal with real farm data has prompted many to question the need for statistical analysis at all. Certainly, simple statistical procedures are preferred over complex analysis, especially as skills and computers may not be available at all sites. Some participants suggested that greater reliance be placed on social science techniques such as case studies and process documentation. This was particularly true for systems experiments involving multiple simultaneous intervention (trees, crops, goats for soil conservation, crop production, fodder/wood production and meat/milk production) where no satisfactory design and analysis procedures were forthcoming. The need for systems design will only increase as most current farming systems research programs dominated by single commodity and or single component experiments progress into more holistic experiments.

Many participants observed that the vast majority of so-called farmer-led experiments are still led by researchers. Indeed, farmer roles are relegated to providing land, labor and information. The notion of farmers as partners and as having a say in what is studied is rarely put into practice. Various ideas for handing over the control or leadership of these farmer-managed trials to farmers were discussed.

Greater leadership by farmers in the planning stages may be achieved through using natural "user" groups of farmers over a contiguous area. Supporters of spontaneous groups emphasized the importance of understanding the variation within any group. Others argued that to ensure fair representation of the communities or target farmer-clients, groups should be selected systematically. Another idea was to build experiments around farmer-identified successful solutions. Technologies coming from a group of successful farmers act as the point of intervention for the trial rather than technologies coming from the experiment station. Similarly, experiments can be built around the farmers' own trials. Indigenous experiments go on all the time. One procedure is to monitor only the farmers' experiment in the first year and add "outside" interventions to the treatment list in the second year.

Greater decision-making powers can be given to fanners at the outset of the trials through offering them a range or menu of trial themes and treatments to select from. One caution mentioned was to make sure that sufficient numbers of farmers elected any one option to provide a meaningful test. Similarly, greater decision-making power can be given at the end of the experiment through giving more weight to farmers' judgments. Using farmers' evaluation criteria and ranking or scoring of effects was one technique suggested. In this area one must be sensitive to gender issues as evaluation criteria, and scores may differ between the sexes. For such farmer evaluation to be influential, it must be fed into the formulation of recommendations or the redesign of experiments.

The group also emphasized the need for greater participation of extension workers in on-farm experiments. Greater extension participation might be achieved through holding farmer field days to which extension agents are invited to bring their contact farmers. Similarly, extension techniques using farmers as trainers of other farmers do bring extension agents into closer contact with research. It is believed that higher levels of researcher/extensionist contact and cooperation will bring with them faster and more efficient dissemination of technology. Extension workers also can provide important feedback to research on the performance of technologies over different managerial and physical environments.

RESEARCH AND EXTENSION LINKAGES

The first issue discussed under research/extension linkages was how to rationalize FSR/E approaches with existing research and extension structures. Although countries have very different research and extension structures, it was agreed that many did not provide effective working conditions for the planning and implementation of farming systems research and extension programs. Two strategies were proposed to rectify this. The first was a radical reform of existing research and extension structures. Some argued that radical change is necessary in order to harmonize objectives and management procedures and is essential to the development of common operational methods. Others suggested a second strategy of step-by-step improvement of existing research and extension systems. A first step would be greater involvement of extension staff in on-farm research. This would be followed by integrating the training of farmers, extension agents and research; the greater employment of women in research and extension systems; and so on until FSR/E approaches were fully integrated. It was pointed out that there were examples of systems in which there had been a number of significant structural changes and also examples in which some of the above steps had taken place. There were useful lessons from these experiences.

Research linkages with extension might, it was said, be facilitated through the use of farmer groups and farmer organizations. More effective links could be developed through joint research and extension identification of and communication with user groups. Greater involvement of these groups in research planning processes and evaluation of research activities was also recognized. Farmer groups enhance farmer-to-farmer extension techniques. Such developments improve acceptability of technologies, provide more effective exchange of ideas and knowledge and give greater accountability of research and extension workers to then clients.

Modern communication methods do facilitate linkages between researchers and extensionists. The group decided that there was a need for greater use of and experimentation with modern communication methods, going beyond radio to slides, tapes, shows and video games for linking researchers, extensionists, FSR/E staff and farmers. Such methods have value not only in training but also in enhancing communication among farmers themselves.

The group also discussed the importance of involving Non-Government Organizations (NGOs) and the private sector in research/extension linkages as everyone recognized their experience in development activities. NGO methods for communication, training, identification of priorities and development of interactive activities with communities were considered particularly relevant to good research/extension linkages. Knowledge of this experience leads to improved methods for on-farm experimentation and other types of iterative research and training. On the other hand, private-sector activities were seen as both positive and negative. Some felt that interests of private agencies might not be compatible with FSR/E objectives of helping poor farmers and removing indebtedness. However, research and extension could usefully act jointly to monitor and moderate private-sector activities and also work collaboratively where appropriate.

APPLYING FARMING SYSTEMS RESEARCH TOOLS IN THE DEVELOPMENT OF MULTIPLE CROPPING SYSTEMS: AN EXAMPLE FROM NORTHEAST THAILAND

Viriya Limpinuntana, Nongluk Suphanchaimat and Keith Fuglie[1]

INTRODUCTION

Fanning system research methods provide a relevant framework for the design of research and extension programs aimed at generating new technologies for rural households to adopt. The Farming Systems Research Project at Khon Kaen University has been using such a framework to develop multiple cropping systems that are adapted to the environment of the Northeast Region of Thailand. The central part of this effort is a strong interdisciplinary on-farm research program. The on-farm research program uses on-farm trials and survey methods conducted by interdisciplinary teams to obtain data on the performance of proposed technologies at farm level Research teams led by agronomists and social scientists cooperate with fanners in research design and operation. In addition, the University has established linkages with action agencies such as the Department of Agricultural Extension (DOAE) to promote not only new technologies but also farming systems research and extension, methods.

This paper reports on the development of one such technology, the peanut-after-rice cropping pattern in rainfed paddy areas of Khon Kaen province, Thailand. Not only does this cropping system offer additional sources of income for farmers, it can also improve soil productivity through careful management of crop residuals (De Datta and Hundel, 1984). In the next section of the paper, the history of research on this cropping pattern is sketched, and special note is made of the inclusion of farming systems principles during the course of the research. In the second section, methods used in the evaluation of the on-farm trials are presented, including structured and semi-structured interviews to identify the key economic and social factors determining acceptance of this cropping pattern. In the third section, the results of the socio-economic analysis are reported. Since on-farm research has been underway for several years, it is possible to report on some of the dynamic elements associated with technology adoption and non-adoption. The final section of the paper presents some conclusions and gives suggestions for some components of this cropping system that require further research.

RESEARCH ON THE PEANUT-AFTER-RICE CROPPING SYSTEM IN KHON KAEN

As early as 1976, on-farm trials of cropping patterns involving peanuts were being carried out by university researcher in Khon Kaen Province. Peanuts were being tested in cropping patterns in upland areas with Kenaf, cassava and other field crops (KKU-FORD Cropping Systems Project, 1977). However, these trials gained little acceptance from farmers and did not appear to be competitive with the main upland crop, cassava.

Trials in paddy areas appeared to be more promising. Figure 1 displays the sequence of these patterns over the growing season. Peanuts can be grown before rice, depending on the availability of labor (especially during the rice transplanting period) or after rice if there is sufficient residual soil moisture in the early part of the dry season. Peanuts grown after rice are planted in late November or December and harvested in March or April. This is followed by a three- to four-month fallow period before the next rice planting. But these yields were still not stable enough to be acceptable by farmers. Peanuts grown before rice often suffer from water logging, and peanuts grown after rice sometimes dry out before harvesting.

In 1981, new on-farm experimental techniques were employed. In addition to crop scientists, social scientists were added to the team. Greater emphasis was placed on studying cropping techniques that farmers themselves had developed and the socio economic environment in which they operated. This involved studying an existing cropping system of peanut-after-rice in the southern part of the Northeast Region (Surin province) where farmers have traditionally practiced this cropping pattern. The inclusion of social scientists allowed for a more detailed investigation into the social and economic constraints faced by farmers.

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The University researchers found that Surin farmers employed agronomic techniques that were significantly different from those that the researcher had been using. Farmers planted the peanut crop as late as November/December while the project had tried an earlier planning date. They also practiced thorough land preparation with deep seeding and selected plots known to have a high water table during the early part of the dry season (KKU-Ford CSP, 1983).

In this study, a social scientist was included in order to investigate the social and cultural interaction of the cropping system with other farm enterprises. One contribution of the social scientist was the observation that farmers typically planted peanuts in plots close to their house or near to their other enterprises. Even through not much labor was allocated to peanut crop care between planting and harvest, farmers needed to keep watch over their fields to make sure that free-grazing livestock did not graze on the peanut plants.

Similar agroclimatological sites were chosen in Khon Kaen Province. Preliminary test plots were established in the dry season of 1981/82. Satisfactory yields were obtained, especially in areas where high soil moisture was noticed as late as January. Similar trials in 1982 and 1983 confirmed the acceptable peanut yields. In the 1984/85 crop year, the trials were extended to villages in six districts of the Province in a project involving about 60 farmers and the Department of Agricultural Extension (DOAE) with support from a University interdisciplinary team. In the following year, the DOAE conducted additional multilocational testing, and University researchers continued to follow up on the acceptance (or nonacceptance) of the cropping pattern with participating farmers. By identifying constraints to adoption, these findings can assist in the design of more effective research and extension efforts. Table 1 outlines the progression of these research efforts to date.

On-farm Research Methods for Analysis of Technology Adoption

The rural household in Northeast Thailand, as in most developing countries, is faced with severe resource constraints and has several objectives. Resources must be allocated between competing crop, livestock, household and off-farm enterprises in order to meet household subsistence requirements, pay debts, make capital investments and purchase consumption goods. This paper considers the household as the decision-making unit, allocating these resources in such a way as to maximize these objectives, as well as other objectives that we are now only beginning to understand.

The key agricultural resources of these households are land, labor, livestock and other capital assets and the ability to acquire working capital (credit) for the purchase of seeds, fertilizers and other cash inputs. The adoption of the peanuts-after-rice cropping pattern or any other new technology will largely be determined by resource constraints and the returns to farm resources from this enterprise. If a farm is not able to obtain the necessary resources or if better alternatives exist, then the new technology will not be adopted.

Dynamic learning processes are also crucial to the adoption decision. Initially, the farmer may have little or no direct information on the performance of a new technique. During the initial stages of adoption, one can expect substantial allocative errors and underutilization of profitable new techniques, particularly since subjective risk is likely to be high. Only through years of experience will the farmer obtain enough information to be able to judge the contribution of a new technique to meet household objectives and be able to allocate resources appropriately.

The central component of an on-farm research program is the on-farm trial. To test a new technique under local conditions, researchers and farmers cooperate and share resource costs. For example, the on-farm trials conducted by the university team researchers provided technical expertise and cash inputs while farmers provided labor, livestock and tools for cultivation and land. Sharing resource costs is one way to reduce subjective risk and improve resource allocation by speeding the adoption process, so long as such subsidies do not become permanent.

In the dry season of 1984-85, the first multilocation testing of the cropping pattern was started in six districts around Khon Kaen as shown in Fig. 2. A group of 60 farmers was involved. Each farmer was provided with enough seed, fertilizer and pesticide for 1 rai (0.16 ha) of peanuts. They were instructed in the Surin method of field preparation and planting. After the peanuts were harvested, each farmer was surveyed in order to obtain data on household characteristics, peanut crop budgets and also the crop budgets of other dry-season crops. Each farmer was interviewed using a structured questionnaire.

In the 1985-86 crop year, about a third of these farmers quit growing peanuts, mainly because low rainfall in the rainy season had significantly reduced the usual amount of residual soil moisture that the peanut crop depends upon for plant growth. Farmers who continued to grow peanuts received technical support from the DOAE. Structured surveys were used to construct crop budgets.

In the next rainy season, drought again reduced rice yields and residual soil moisture considerably. Farmers in the southern part of the Province (area E) dropped out of the peanut trials entirely. However, farmers in other locations were still cooperating with the DOAE, and some had begun to plant peanuts after rice on their own.

Despite a decrease in the overall number of farmers in the five sites, there were some farmers who had been continuously planting peanuts after rice since 1984/85. A team of University researchers therefore conducted semi-structured interviews with 24 farmers in March 1987 in order to document the characteristics of farmers who had continuously planted peanuts versus those who had not. This investigation focused on the physical and biological conditions of the plots, household characteristics of participating farmers, the allocation of inputs, yields obtained and the farmers' attitudes toward extension services.

The semi-structured interviewing method used group interviews between a interdisciplinary investigation team and individual farmers. Before going to the field, the team sketched out the main topics to be addressed and established a protocol for the interviews but did not predetermine all the questions as in a structured questionnaire. During the process of the interviews, the list of topics was modified in order to focus on what the group determined to be the key issues. Some fanners were interviewed in order to get information on new topics that arose. Immediately after the interviews were completed (before leaving the field), the team wrote a draft of their findings. This assured that the results of the survey would be available in a timely fashion.

To determine the economic competitiveness of peanuts in the farming system, information from the structured surveys was combined with the findings of the semi-structured interviews. Partial crop budgets were constructed for peanuts, corn and cucumbers (also grown in the dry season using hand-carried irrigation from wells or ponds). The returns to family labor, land and cash inputs were compared. These were the main household resources expended on these enterprises. Sensitivity analysis was also used to predict the minimum acceptable peanut yield. The semi-structured interviews also gave additional information on other physical and socio-economic constraints faced by fanners that affect the adoption decision.

Socio-Economic Evaluation of Peanuts-After-Rice

The average size of farms that participated in the trials was 325 rai (5.2 ha) of which about 56% was paddy and 44% was upland. Almost all of the farmers surveyed used an improved local rice variety (RD 6) and applied little or no chemical fertilizer. Average rice yields were 275 kg/rai. (1.72 ton/ha). The area of paddy that could be allocated for dry-season crop was small and scattered and determined mainly by the availability of residual soil moisture. Therefore, farmers could use only a small portion of their paddy land for dry-season crops. As a percentage of income, dry-season crops accounted for 12% of the value of total crop production and 6% of total income. During the dry season, however, only one or two persons are typically available for full-time farm work per family compared to three or four adults during the rainy season because many family members find off-farm jobs during this period.

Despite the low proportion of income from dry-season crops, there is an increasing number of farmers who seek suitable areas for dry-season crop production, especially those who have fewer off-farm employment opportunities or who cannot leave their families. Before peanuts were introduced, there were farmers who had already planted some cash crops in the dry season on a very small scale in paddy areas located near shallow wells. These crops included sweet corn, cucumber and other assorted crops, which are irrigated using shallow wells and hand-carried buckets. Several farmers borrowed paddy land from neighbors without charge if their own land was not suitable. This suggests that there is no direct rental cost at the present for the paddy in the dry season. Indirectly, the owners can realize the rotation effects to their following rice crop. The introduction of peanuts after rice without hand watering widens the area for dry season crops and also increases the number of farmers who can engage in these activities.

The critical question is to what extent is the peanut crop competitive with other crops, especially sweet corn, in the areas where each can be grown. To determine this, partial budgeting methods were used. The return to the three major inputs (land, labor and cash expended), were calculated for peanuts and for other crops that were competing for the same resources. The labor wage rate was set at 25 baht/day or about 3-4 baht/hour. This rate remained constant in the dry season during the three-year period. It is used to reflect the opportunity cost of labor in the dry season. Two main sources of institutional credit are farmer cooperatives and the Bank of Agriculture and Agricultural Cooperatives (BAAC), which charge an annual rate of interest of 14%. But small- and medium-sized farms often have difficulty getting short-term credit from these sources, particularly if they do not have acceptable forms of collateral such as a formal title to their land. As a consequence, they often obtain credit from the local lenders for small and short-term loans. The interest rate from these lenders is typically around 40%/year.

The non-institutional interest rate was used to evaluate the cost of fanners' cash investments in the crop budgets. Cost of animal power and depreciation of farm equipment resulting from growing an additional crop were ignored since few implements were used and there was little or no opportunity cost for these items during this period. Table 2 presents the average farm-gate prices used in the analysis drawn from the farm surveys.

The economic competitiveness of peanuts is compared with other crops in Table 3. On average, peanut yields were about 165 kg/rai but varied widely from location to location. At average yield, peanuts gave smaller returns to land and labor then did corn and about the same or slightly higher returns than cucumbers.

However, it is important to also consider the value of residual effects of these crops on the following rice crop. Peanut functions as a nitrogen-rich green manure due to the plant's nitrogen fixation capability. Other studies (Wilairat, 1984) have shown that growing peanuts in rotation with rice can increase rice yields between 0 and 35%, depending on crop management practices and rainfall in the subsequent rainy season. Other crops grown in rice paddies in the dry season also appear to have some positive residual effects on rice yields, but these are not as significant (Chaiyasuj and Fuglie, 1988). These increases in rice yields will result in higher returns to peanuts and make peanuts more competitive with corn and other crops. Additional research is needed to quantify this factor, but it is an important consideration in the overall cropping system.

One major problem of the peanuts grown in the dry season is the high variation in yield from one location to another. This is mainly due to differences in residual moisture in the soil, how well the land is prepared before planting and the quality of the seed. The returns from peanuts were therefore calculated for each location and group according to high, medium or low yield performance (Table 4). Farmers in area D obtained the highest average yield and received a favorable return from peanuts compared to corn. Some farmers in this area indicated that they were obtaining supplement moisture from the township's water drainage system. In addition, they had access to high-quality seed at reasonable prices from farmers in a nearby village who planted peanuts in the rainy season as a cash crop in upland areas. The farmers in area D have been planting peanuts after rice continuously since the 1984/85 crop year. In areas A and E, the average yields were only 100 kg/rai, and returns from peanuts were unacceptably low. Several farmers in these areas dropped out the trials, even though they were given free inputs. These results suggest that peanuts after rice may not be a promising crop pattern in areas A and E.

Farmers were obtaining a medium level of yield in areas B and C with the return to labor almost equal to the wage rate (opportunity cost of labor). Sustained adoption is still uncertain in these two areas. Higher peanut yield can be expected if there is good rainfall in the preceding rainy season since this will increase the residual soil moisture. Other factors may also contribute to higher peanut yields, such as availability of good quality seeds and better land preparation.

The semi-structured interviews also revealed several more aspects about how cultural practices and the constraints faced by these farmers influence adoption. The results reported below are drawn from the report prepared by the interdisciplinary team (Wongsamam, et. al., forthcoming). The decision to plant peanuts or sweet corn depends not only on the net returns, but also on the availability of good seed and labor, whether or not the farmer is a landowner and the location of a farmer's land.

The availability of certain types of family labor during the dry season was one key factor determining the cropping decision. Cultivation land for peanuts required the use of livestock (and therefore male labor) whereas sweet corn was planted using a hoe and stick and could be accomplished by female labor alone. However, sweet corn required daily irrigation from shallow wells. Thus, peanuts were the preferred crop of farmers who could have manpower for plowing but did not have labor available for hand irrigation. However, sweet corn was often preferred by female farmers. Furthermore, peanuts required more labor (a team of three to four persons) at peak periods but little labor in between planting and harvesting. Sweet corn, in contrast, could be grown by one or two persons but required a steady amount of labor throughout the growing season. As a consequence, peanuts are typically planted immediately following the rice harvest, when there is usually enough family labor on hand. When peanuts are harvested, additional labor can be drawn from women and children.

Another finding was that all farmers who planted peanuts continuously for three years were also landowners. This might indicated that landowning farmers realize additional gains from the positive rotation effect on subsequent rice yields. An additional residual benefit is that peanut leaves, while fresh, can be fed to livestock. Peanuts also have a marketing advantage because they can be stored during the drying season in order to fetch a higher price. Farmers owning land are generally able to bear the carrying cost.

However, we also found that landless farmers or young farmers, especially female, who remained on the farm, tended to grow corn instead of peanuts. Three major reasons were given by interviewees. First, corn

requires less initial cash for seed (60% of the cash cost for peanuts) and also provides good cash flow, because during the harvest period, a few fresh ears can be harvested each day and sold in the village or town. Second, because many of these farmers are borrowing their neighbors' paddy for dry-season crops, they are primarily concerned about the return to labor and cash investment and not about potential gains from residual effects. Finally, growing corn does not need thorough land preparation or the use of buffaloes. Thus, most young female farmers can start planting corn after the rice is harvested and are able to bear the labor-intensive hand watering task.

Farmers prefer to grow dry season crops in plots near the village where they can protect the crop from free grazing livestock. This was also found to be the case in Surin Province, where fanners had developed the peanut-after-rice cropping system on their own. If suitable land for dry-season crops is located far from the village, it will probably be worthwhile to grow peanuts only if there are other activities near that site to occupy the farmer, such as fish raising or vegetable production.

Access to good peanut seed is a major constraint to this cropping pattern. Seed that has been stored for a year or more often has poor germination. Fanners prefer to get new seeds or good seeds from the extension agents. One possibility is for farmers to allocate part of their upland area to peanuts in the rainy season in order to get fresh seed for the dry season. However, this suggestion is viable only if farmers have access to both types of land. Moreover, farmers will incur additional cost of foregone earning from upland crops such as cassava. Using peanut seeds from the previous dry season is another alternative, but the quality may not be as good as the rainy season peanut seeds.

Finally, growing peanuts in the paddy in the dry season in Khon Kaen province is still a new practice for many farmers. Many are still experimenting with the technique, and it may take several years before farmers are fully familiar with the technology. Thus it is important for extension programs to work with the same farmers for an adequate period, with continuous provision of technical support to them.

CONCLUSION

Increasing the intensity of paddy land use can serve as a way to enhance agricultural productivity and give additional income to farmers in the Northeast Region of Thailand. Significant research efforts are being devoted to developing suitable cropping systems in the rainfed areas of the Northeast This paper briefly traces the past efforts of Khon Kaen University in testing a peanuts-after-rice cropping pattern using a farming systems research approach. Successful practices of farmers in the southern part of the Northeast Region were studied using interdisciplinary teams. These techniques were then transferred to other parts of the region. Multilocation testing of this particular cropping system has been attempted since the 1984/85 crop year.

The economic evaluation of the peanut cropping pattern is based on three years of survey data gathered from structured and semi-structured interviews conducted by interdisciplinary teas. These surveys not only provided information on the economic returns to peanuts, but also revealed social and technical constraints faced by farmers. The economic data suggest that peanut yields of 165 kg/rai will be only marginally competitive with yields form other crop. Where yields are 220 kg/rai (as obtained in area E), however, peanuts will give higher returns to labor than other crops. This demonstrates the overriding importance of appropriate site selection. The cropping decision is also influenced by other factors, such as labor availability, access to quality seed for planting, whether or not the farmer is a land owner, the distance of the plot from the house and village and cash flow preferences.

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Table 1: The Progression Over Time of Peanuts-After-Rice Cropping System Research by Khon Kaen

ACTIVITY	AGENT	TIME PERIOD
Began testing peanuts in rainfed cropping system	KKU - FORD CROPPING SYSTEM PROJECT (CSP)	1976 -1980
Studied farmer techniques in peanuts after rice under rainfed conditions in Surin Province	KKU - FORD CSP	1980 -1981
Tested Surin techniques in one village In Khon Kaen Province	KKU-FORD CSP AND FARMING SYSTEMS PROJECT	1982 -1984
Conducted multilocation testing of peanut after rice cropping system using Surin techniques	KKU - FORD AND DOAE	1984 -1985
Further multi location testing of this cropping system in Khon Kaen	DOAC	1985 -1987
Review of adoption/non-adoption by participating farmers	KKU - FSR	1985 -1987

Table 2. Average Prices Used in the Crop Budget Analysis

ITEM	PRICE	ITEM	PRICE
Output		Input	6.5 b/kg
rice	2.3 b/kg	peanut	5.0 b/kg
peanuts	4.6 b/kg	fert.(15 -15 -15)	15.0 b/bottle
corn	0.5 b/3a4	furidol insecticide	25.0 b/day
cucumber	4.0 b/kg	labor wage rate	40% per annum
avg. rice yield	275.0 kg/rai	cost of borrowing	

Table 3: Con paring the Returns of Peanuts and Competing Crop.

ITEM	PEANUT	CORN	CUCUMBER
CASH COST (BAHT)	238.0	360.0	121.0
seeds	162.5	99.0	75.0
fertilizer	61.5	219.0	25.0
pesticide	14.0	42.0	21.0
INVESTMENT COST (40% PER FOR 4 MO.)	31.7	47.9	15.7
TOTAL COST	269.7	407.9	113.3
YIELD (KG/RAI)[1]	164.5	2589.0[2]	117.5
GROSS RETURN (BAHT)	756.7	1294.5	470.0
GROSS MARGIN (BAHT)	487.0	886.6	332.27
TOTAL LABOR (HR.)	138.5	191.0	96.0
RETURN TO LABOR (B/HR)	3.5	4.6	3.5
RETURN TO LAND (B/RAI)	57.7	289.7	34.67
RETURN TO CASH (B/B)	1.4	1.9	1.4

[1] 6.25 rai = 1 ha
[2] yield measured in ears per rai

Table 4: Returns to Resources at Each Location Showing the Sensitivity to Peanut Yields.

ITEM	SENSITIVITY TO LOCATION		
Location	A, E	B, C	D
Average Yield (kg/rai)	100.0	164.5	220.0
Gross Return	460.0	756.7	1012.0
Variable Cash Cost	269.7	269.7	269.7
Gross Margin	190.3	487.0	742.3
Labor requirement[1] (hr)	180.1	138.5	162.5
Return to Labor (b/hr)	1.8	3.5	4.5

[1] variation due to labor required for harvesting

LAND TYPE	CROPPING PATTERN	MONTH
		M A M J J A S O N D J F M A
Upland	Peanuts in rainy season	-PEANUTS--- ---PEANUTS--
Upper/Lower Paddy	Monocrop rice	+++++---RICE-----
	Peanuts-Rice	---PEANUTS--+++-RICE-----
	RICE-Peanuts	++++-RICE----- ---PEANUTS

+++++ indicates rice transplanting period

Fig. 1. Typical peanuts cropping patterns.

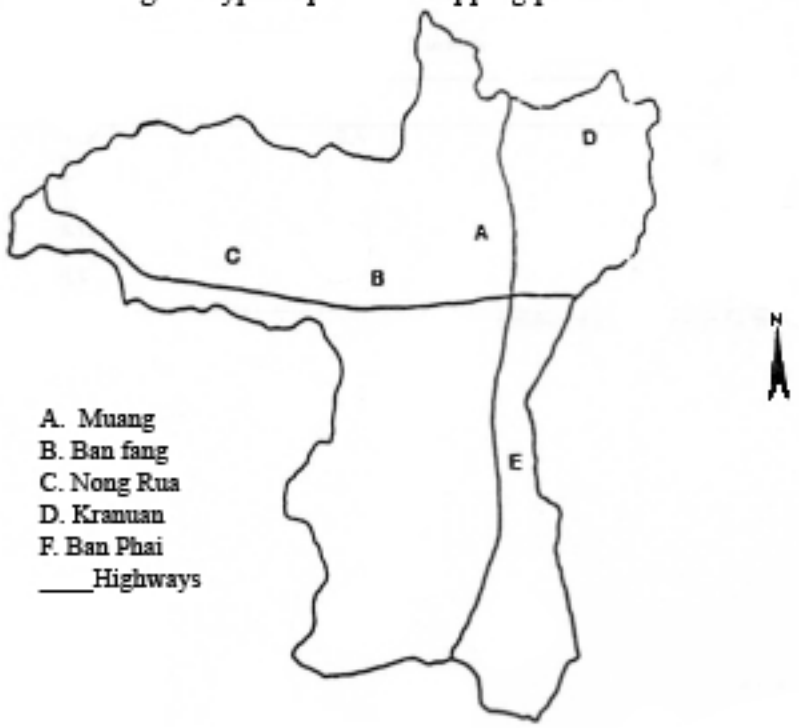

Fig. 2. Districts involved in the multilocation testing of the Peanuts-After-RIce Project in Khon Kaen Province.

LINKING FARMING SYSTEMS RESEARCH (FSR), EXTENSION AND FARMER: A PAKISTAN'S PERSPECTIVE

Waqar H. Malik[1]

ABSTRACT

The longevity and successful implementation of FSR calls for substantial involvement of extension agents and farmers in its operation from inception to end. The research scientists, who are a rare commodity, cannot plan, supervise and implement all FSR projects/experiments all over the country. On the other hand, extension personnel who blanket the countryside are in a better position, if involved from the beginning, not only to coordinate the FSR efforts at the field level, but also to extend the site-specific FSR results with more vigor and confidence to fanners. Similarly, farmers, the ultimate consumers of the technology, have an important role in identification, development, dissemination and utilization of the proposed technology.

Although there is no denying involving these three groups in FSR, the problem arises at the level of their involvement and the role each is supposed to play. It is generally observed that an FSR team visits a site, a village or a location and contacts the local resource persons who could be reached easily for investigation. However, extension agents, farmers and others are consulted in a cursory manner up to the extent where they are useful in providing a certain kind and amount of information that the FSR team deems essential to conduct a survey.

This paper discusses the various principles, issues and constraints involved in linking FSR with extension and farmers. It also proposed some meaningful measures to achieve institutional linkages among these three groups in the light of FSR experience gained in Pakistan.

INTRODUCTION

Unless a strong link among the components of agricultural technology generation, articulation and application exists, the chances of the success of FSR are very remote. All efforts may come to no avail if a discovery does not find the right kinds of avenues to travel and does not answer the problems farmers encounter in the field.

The basic premise of the FSR/E approach calls for greater involvement of small-scale farmers operating in more marginal agroecological conditions who were not able to benefit from the technological advances under-pinning the Green Revolution. One of the major shortcomings attributed to the traditional research procedures has been the absence of involvement of extension and farmers in research formulation. This has often resulted in a top-down technology not appropriate to the vast majority of users.

A growing body of the literature supports the notion that the prime reason for small farmers' nonadoption or slow adoption was that the innovations either were unsuitable for their socioeconomic circumstances or were incompatible with the prevalent farm practices. Simmonds (1984) concludes that the small farmers are economically rational but risk-averse and sharply constrained by uncertain environments and shortage of cash. They are willing enough to adopt innovations that they themselves perceive to be economically attractive. Accordingly, the notion has grown that research should be determined by explicit farmers' needs rather than by the preconceptions of researchers.

Another concern usually voiced about such a technology-generation approach is its built-in bias toward more innovative, progressive and big farmers who have access to both the package of production technology and the means of production. For effective utilization of scientific farm information, it is vitally important that researchers, extensionists and small farmers be involved in the process of technology generation, diffusion and utilization.

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FSR-EXTENSION-FARMER LINKAGE ANALYSIS

FSR has already completed about 15 years in most parts of the world, and an enormous number of experiences and insights have accumulated across the globe. Therefore, it seems essential to review 1) how much FSR has succeeded in bringing research, extension and farmer closer to each other; 2) to what extent it has succeeded in developing technologies appropriate to and useful for small farmers; and 3) how the harmonious and collaborative relationships could be fostered among the members of three groups -research, extension and production.

The current FSR performance in terms of involving extension and farmers along with researcher does not present a bright picture. Farmers' involvement in various stages of FSR is limited to the extent that he/she is useful in sharing his/her information with researchers to accomplish their diagnostic surveys, plant on-farm trials and do future FSR planning, Likewise, extension agencies do not contribute to the extent they could in the process of FSR. At many places extension agents are not considered an important part of the FSR program.

This paper draws on a couple of practical examples from Pakistan where, as in many other settings, FSR has not brought much change in the attitudes of the researchers involved in Farming Systems Research. Although a myriad of on-farm trials were extensively planted, farmers were reached only for seeking information at the time of diagnostic surveys and, subsequently, for soliciting their consent to plant trials on their lands. They were never considered as active partners in the on-farm FSR activities. Such trials were planted in the same traditional fashion. This has buttressed the farmers' feeling that scientists come to their fields as part of their official business, and the fanners are supposed to provide their lands; in lieu of remuneration, they get farm inputs.

The social distance between researchers and farmers has continued to widen rather than narrow, Promotion of dialogue and interactive listening-learning process between an FSR team and farmer does not exist. The scientists pay quick visits to their trials for taking readings and return to the research stations immediately. Likewise, it is not the norm to contact farmers after the harvest of trials to inform them of the results and the insights researchers gained from the activities carried out at their fields.

Another area of concern is that much of the FSR has focused on cropping subsystems and the production decisions of farmers. Little attention has been given to understanding livestock, agroforestry, marketing and off-farm employment individually as a subsystem and to integrate each of these into the overall perspective of the farming system. This harks back to the Green Revolution "commodity approach" in which researchers had a tendency to overemphasize production technology and downplay the role of the "human element" in farming systems. A decade ago, Dillon et al. (1978) noticed a similar problem in some of the International Agricultural Research Centers (IARCs). They urged the IARCs to devote more attention to crop and livestock interactions, on-farm trials and village and socioeconomic studies.

Compton (1981) suggests an interactive model in which the FSR team along with other actors responsible for agricultural knowledge discovery-transformation-utilization are assigned a two-way dynamic role to play. Compton's systems matrix (Fig. 1) rightly juxtaposes the research, extension and farmers and proposes a framework to analyze extension relationships with traditional research, FSR and farmers. Cells C and G in the matrix suggest a need for multidisciplinary teams of scientists to study at a close focus the problems and needs of small farmers through an interdisciplinary methodology. This could be done by sending such teams into each agroeconomic region and involving a few farmers in the research effort. The major focus would be to identify factors and forces impinging upon the farming systems and to determine the right kinds of solutions to solve those problems. While Cell C suggests an effort to study the relevance and application of scientific knowledge to farmers practices, cell G poses the obverse questions, i.e. the extent to which indigenous knowledge and farmer practice are embodied in what scientists recommend.

Extension-Farmer Role in FSR

As mentioned in the foregoing, the centerpiece of FSR's success is intended to be its strong linkages with the technology diffusion system and with the users who put the FSR-generated technology into practice.

It is obvious that the agricultural research force in most of the developing countries is small relative to the number of extension agents. Thus, neither can the scarce handful of research scientists plan, supervise, monitor and implement all FSR activities all over the country nor can they purvey its findings nationwide. Moreover, in the long run when a specific FSR project or activity is over, researchers have to go back to their research institutions. In other words, their relationship with farmers may not develop on a sustained long-term basis.

On the other hand, extension agents who blanket the countryside are in a better position, if properly involved, not only to coordinate and facilitate FSR efforts at the field level on a sustainable basis, but also to purvey the site-specific technology with more vigor and confidence to farmers and make sure of its utilization.

Widespread dissemination and application of FSR results and involvement of fanners in the FSR operation certainly demand assistance of legions of extension workers who are adept in the diffusion of information. Also, the sustenance and longevity of FSR calls for timely involvement of extension staff. However, the Pakistan experience suggests no involvement of the extension agency in the whole process of FSR from inception to end, while the farmer participation is limited to a few on-farm trials. As a result, extension agents and farmers feel alienated and are becoming skeptical about FSR and the findings it generates. They are of the opinion that FSR is another "slogan" imported by the government to overcome unemployment problems of agricultural professionals or to meet some other objectives.

FSR needs to have extension involved in the process, as extension workers have an edge over researchers in becoming familiar with the conditions necessary for conducting FSR into specific problem situations. Extension, because of its broad and continuous coverage, is in a position of being at least potentially able to identify on a wide-scale basis particularly interesting and possibly fruitful indigenous practices or innovations that themselves might warrant being the subject for some good FSR/E.

FSR can draw extension personnel necessary to carry on various field activities throughout large and agriculturally diverse regions. The limited number of research scientists with multifaceted research responsibilities makes it extremely unlikely that such scientists will have enough free time to focus on more than a few FSR activities. A developing country such as Pakistan can ill afford to divert its scarce scientific research force from important fundamental research for the sake of participation in applied FSR activities over a long period of time. The solution to such a problem lies in developing the capability to conduct such research within the extension service.

Extension workers' knowledge about the local situation at the farm level and the responsibilities they eventually will have for disseminating the results of FSR makes the involvement of extension workers at each stage of the FSR process essential

It is vitally important to involve the farmers who are the ultimate consumers of the proposed innovations in question formulation, problem identification, development, transmission and application of the new knowledge. Farmers' indigenous knowledge and experience can also help to tailor a technology package that has compatibility to their needs. Farmers have no problem fitting the new knowledge into their own situation and figuring out how it will be likely to affect them.

Of equal importance in the formulation is the role of indigenous specialists (IS), otherwise known as progressive farmers or legitimators. Agricultural science specialists and indigenous specialists need to be in closer and more frequent contact with each other. The services of indigenous specialists would free up village extension workers to spend more time to work with the structuring and functioning of farmer associations and adult learning groups.

While there is no denying the fact the extension agencies and farmers can bolster and facilitate FSR operations and can make the work of scientists a whole lot easier, the question is how to achieve a rapport among the members of these three diverse groups. Before looking into this question, it seems important to examine the prevalent problems, shortcomings and constraints that impinge on the whole FSR-Extension-Farmer environment and are responsible for the faltering relationships between researchers and extension agents.

Factors Influencing Researcher-Extension Worker Interaction

Compton (1984) identifies some of the communication constraints that influence the information flow between researchers and extension workers. He points out that research and extension, being separately administered entities, have come to differ in regard to the kinds and levels of qualifications required of their personnel and the amount of experience that is required for entry or promotion into higher positions of responsibility. Research and extension groups are headquartered apart from each other. This spatial separation, in conjunction with the above factors, tends to foster separate conceptual approaches to dealing with the problems of farmers.

The two groups also have a tendency to view each other very differently. Research scientists view extension workers as being unwilling to trust or accept research findings, unwilling to ask researchers for information, not helpful in clarifying the nature and extent of field problems, and demanding of immediate answers to complex problems that require long-term effort. On the other hand, extension workers view research scientists as being

secluded in their laboratories, unconcerned with the social and economic impacts of their research, noncommittal about their research results and prone to use obtuse language in their writings and reports.

Also extension personnel receive less pay than research scientists. Extension staff tends to carry a lower status within the department of agriculture and have less opportunity, in comparison to research scientists, of advanced training and career development. The greater the differences in skills, prestige and status among members of a work group, the more difficult it will be to establish and maintain satisfactory interpersonal relationships. A somewhat circular situation occurs wherein poor interpersonal relationships develop as a result of the strain caused by differences in skill, prestige and status, and these thwart efforts to arrive at common goals that might work to improve interpersonal relationships.

Research scientists and extension staff find rare opportunities for interaction. Nevertheless, when such an opportunity occurs, various kinds of strains and tensions between the two groups bedevil effective communication. Some of the kinds of tensions and strains encountered are mere human reflections of organizational strains. The two groups tend to differ in regard to basic professional definitions, focal concerns and role perception. One group tends to emphasize the comprehension of phenomena while the other places more emphasis on changing situation. Both groups develop different value considerations. Communication factors such as the lack of two-way direct relationships, information overloads and differences in language or style of expression also inhibit their interaction. The two groups have different methodological grounding, conflicting views of the utility of practical experience and common sense, different standards for measuring achievement and different views of the utility of negative criticism. Their orientation towards farmers differs in regard to both understanding farmer needs and conceptualizing the nature of risks faced by farmers. They also have and pursue different sources of recognition, have perceived conflicts of interest and have different loyalties and basic identities.

Although the challenge of integrating the work of two such disparate groups is major, organized and systematic interaction appears to be the only solution to this nagging problem. Regardless of how it is achieved, effective interaction between research and extension is central to any agricultural development initiatives.

STRATEGIES TO STRENGTHEN FSR-EXTENSION-FARMER LINKAGES

The foregoing analysis of researcher-extension communication problems leads to the demand for closer integration among FSR teams, extension agents and farmers. Experience suggests that the following interventions, depending on a specific situation, could help revamp the FSR-Extension-Farmer linking mechanism.

First, the FSR team needs to have one extension specialist as its member. Depending on the size and level of an FSR project, local-level extension machinery should also be made an integral part of the program. The extension specialist on the team must be able to develop rapport with the local-level extension agency. These extension staff would not only serve as a good source of fundamental information required in the diagnostic surveys but would save substantial time, energy and efforts on the part of the investigative team.

At some places locating and involving local extension agents would be a frustrating exercise because of the lack of extension agents' interest in and coordination with the FSR team. This might be a reflection of the extension agents' personal unhealthy experience with the research scientists or an attitudinal or non-cooperative behavior of an individual agent. However, involvement of higher-level extension administrators in the program and assigning some specific role to extension agents in FSR should help reverse such a tendency. A little attitudinal adjustment, deference and concession on the part of each team member also would help to achieve this goal.

Second, the number of Subject Matter Specialists (SMSs) who are usually a part of extension services and have adequate professional competence can be increased. This would facilitate the stationing of teams of appropriate combinations of specialists in each important agro-economic zone—important from an FSR perspective. These teams could then be backstopped by highly technical advisory committees composed of capable and talented scientists at research stations and universities. This would make optimum use of a scarce talent. While SMSs have professional affiliations with scientists, they have functional relations with extension workers and farmers. Hence, they have a unique role to bring FSR closer to extension and farmers. Similarly, SMSs have an advantageous position for identifying points of convergence and divergence between indigenous knowledge systems and scientist-derived knowledge systems. This can lead to important FSR steps to check the validity and value of indigenous knowledge and practice and the relevance and adaptability of science-based farm information.

Third, the solution to most of the problems discussed in the foregoing section lies in bringing the members of the three groups closer and making them talk to each other to acquire an FSR mentality—to work in interdisciplinary settings with a farmer-oriented approach to development. This can happen through joint training programs and building a network. The FSR team—research scientists, extension specialist and farmers--needs to be trained in:

- What can they learn from farm operators?
- How can they learn from farmers?
- How can what they learn in this process be utilized in agricultural development?

Finally, instead of relegating the farmer to a status of observer and passive recipient of technology, he/she should be made an active partner in FSR programs. Such an involvement of farmers in the projects will make them more aware of their prerogatives, more vocal in expressing them and more adept in organizing to achieve their mutually desired ends. In so doing, they either consciously or unconsciously expose themselves to FSR-based farm information disseminated through FSR activities and extension channels. Such a strategy would promote not only the farmers' self-confidence but also their capacity as effective users and disseminators of new technology that they have evolved and tested themselves.

In a rural milieu, farmers live on their farms or in a nearby village where the bulk of farm information travels through an interpersonal communication network—farmer-talks-to-farmer. They are in frequent contact with other farmers who may pass by, observe some on-farm trial, ask questions and receive an immediate response. This information exchange makes farmers effective demonstrators and educators. Such farmer-educators provide an effective and trusted means of getting across the FSR and extension message. Farmers are more likely to learn from someone who communicates with them on the same wave length in their own terms and in a style with which they are familiar and comfortable. Extension agents can, at best, visit farmers once every two weeks. The timing of the visit may not correspond with the "teachable moment." Farmers observing, listening to, and learning from other farmers are in a position to take what they are seeing and hearing and adopt it to their own situation. Extension agents have no way of affecting such a process.

The foregoing suggests selection of farmer-educators within an FSR/E framework that embodies two criteria: 1) the appropriateness of the farmers' agronomic conditions and 2) their skill as communicators and educators. Such farmers, with some grooming, orientation and support, could prove an asset to research and extension agencies. They may serve as an effective arm and a conduit for diffusion of FSR-base information and free up field-level extension agents to conduct some organizational and educational work.

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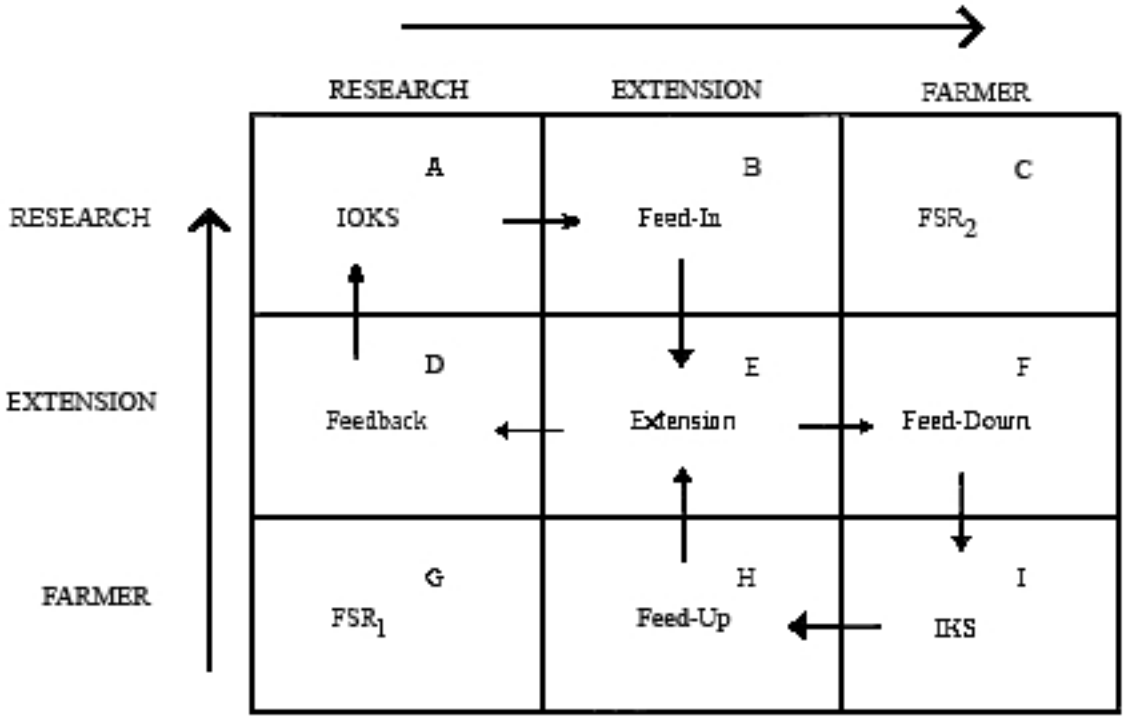

IOKS: Institutionally Organized Knowledge System
IKS: Indigenous Knowledge System
FSR^1: Farming Systems Research (IOKS→IKS)
FSR^2: Farming Systems Research (IKS→IOKS)
ABEFI: IOKS→IKS
IHEDA: IKS→IOKS

Fig. 1. Systems matrix of extension relationships. (Source: Compton, 1984)

A METHODOLOGY TO ASSESS THE IMPACT OF FARMING SYSTEMS RESEARCH IN ASIA

N.F.C. Ranaweera and R.R. Gonzaga[1]

INTRODUCTION

Recently agricultural research programs have been focusing on the resource-poor farmer and attempts have been made to provide technologies that can be used with relatively lower cash cost but that can increase productivity significantly. This has been particularly true in the case of Farming Systems Research (FSR), in which researchers have concentrated on "whole farm" analysis and a systems perspective to research.

With more emphasis being given to strengthening farming systems-oriented research in developing countries, a valid question that is being raised is whether the new technology has had the desired effects in terms of both overall food production and, more significantly, real benefits to farmers.

Generally, economists dealing with agricultural research tend to view benefits using parameters that reflect some components of economic development. Essentially, the questions asked are: Have real incomes and purchasing power of farmers have increased? Has there been increased accumulation of capital assets, both farm and non farm? Has the nutritional balance of the food intake improved? Have the adverse social and economic environments facing the farmers been reduced or eliminated?

Agricultural research's zone of influence in the overall development process is usually limited to the extent of providing only the technology. Other support services and agricultural policies do not necessarily go in tandem with the technology requirements and often lead to a large degree of "non adoption" of the new technology. Associated questions from a development point of view, therefore, are: Have supporting institutions such as extension, credit, marketing and input supplies responded to the new approach? Have agricultural policies supported development programs within a farming systems research framework? Finally, what effect has FSR had on present organization and management?

An impact study of FSR technology should attempt to answer some of the questions posed above. A schematic representation of these questions and issues can be presented as in Fig. 1.

An important consideration in FSR evaluation is that attention should be paid not only to incomes from the crop land per se, but rather to all components of the farm, namely crop land (lowland, highland, etc), home garden, livestock, off-farm agricultural income and non-farm incomes, which may include remittances from children.

An analysis of the total interplay of the resource base of the farm along with consumption and other activities can provide insights to the "real impact" the new technology has had on the farmers.

This paper discusses some methodological approaches that could be used by national programs to assess the "impact" of FSR programs. It is essential that national program capability be developed to undertake "impact" studies as a means of ready feedback to researchers and research managers.

The data for the paper are drawn from studies conducted at Iloilo Province in the Philippines where the International Rice Research Institute (IRRI) undertook extensive cropping systems studies (1975-80) and where during 1987/88 an impact study was conducted by the IRRI Agricultural Economics Department. While the overall research program is identified as Farming Systems Research, this specific study concentrates only on the cropping systems component. Concurrently, there were other country studies conducted in Bangladesh, Indonesia, Philippines and Sri Lanka, using a similar methodology. In April 1988, the results of these country studies were discussed and agreement reached for the studies to continue for three more years in order to attempt to refine the methodology. Before discussing the Iloilo analysis, in the next section, we briefly review other attempts at FSR impact evaluation in Asia.

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PREVIOUS IMPACT STUDIES

Conceptually FSR emphasis is on the "whole-farm" approach. Compared to the monocrop orientation, FSR attempts to consider all farm activities and interrelate the different components of the farm in an interactive manner. A schematic presentation of a whole-farm approach is indicated in Fig. 2. Ideally, this approach should enable a farmer to optimize his limited resources of land, labor and capital in a manner that will maximize his income from his total farm activities.

Methodology for conducting cropping/farming systems research has been developed in a number of research institutions both national and international. They have been enumerated in Gilbert et al. (1980), Collinson (1980), Zandstra et al. (1981), Byerlee et al. (1982), Simmonds (1984) and Norman and Collinson (1985). A comprehensive survey on concepts, methodologies and definitions is presented in Merrill-Sands (1985) and Plucknett et al. (1986). One cause for concern, though, is the confusion that has arisen in the literature regarding a clear identification of what FSR really is. While not dwelling on this, suffice it to say that the Technical Advisory Committee (TAC) in a report to the Consultative Group for International Agricultural Research (CGIAR) in 1979 called for a systematic clarification, ordering and labeling of concepts, activities and methods in FSR; more recently Merrill-Sands (1985) reiterates this, stating "the ambiguity in terminology and conceptualization of FSR has still not been resolved and, in fact, has become more acute."

FSR programs in Asia have been implemented for well over 10 years, and successful programs have been achieved in many countries. Hoque (1984) identified large-scale adoption of FSR technology in rainfed and irrigated areas at Bogra in Bangladesh. McIntosh (1985) described the gains made in Indonesia under both rainfed and irrigated conditions, and Fernando (1979) described the FSR technology adoption under the minor tank irrigation areas of Sri Lanka. Additionally, crop intensification due to FSR activities has been recorded in North and North East Thailand and in Phumdi, Nepal (Mathema, 1986). The technology developed at Iloilo province for rainfed conditions in the Philippines has been extensively adopted by farmers in that province (Quisumbing, 1983).

Large-scale adoption of new FSR technologies has also led to assessment of their "impacts" by researchers within the Asian region. A majority of the studies, though, were confined to identifying the level of adoption of the new technology or any of its components and the extent to which recommendations were being followed. In the Philippines, it was found that when farmers adopted new, more intensive patterns, they often used lower levels of inputs than those recommended (Price, 1980, 1982). Van der Veen (1983) examined the adoption of new technology from Phumdi Bhumdi in Pokara in Nepal, while Djauhari (1983) studied the adoption rates of FSR technology in Indonesia at Bandarajaya, Batumarta and Way Abung. Ranaweera and Siripala (1982) and Ranaweera (1983) studied the adoption of cropping systems technology under minor tank conditions in Sri Lanka, concluding that the impact had been primarily in terms of better crop management with farmers adapting the new technology to meet their specific environments. A significant shortcoming in many of the above studies is the lack of undertaking of the production-consumption components to establish whether increased production has necessarily benefited the farmers reflected through their consumption activities. Barlow et al. (1983), evaluating new technologies on rice farms in the Philippines, attempted the incorporation of income-expenditure patterns in the study.

Approaches Used

A major problem facing researchers attempting impact studies that consider both production and consumption aspects is the lack of an easily usable methodology that could be adapted to individual country situations. The complex situation that exists in a family farm in terms of the interactions between income and expenditure and the different farm components as well as the difficulties in measuring certain parameters make such studies difficult. The problems relating to nonadditive utilities when dealing with a large number of arms compounds the problem. As Anderson (1985) states, complications arise due to "...the multiple attributes by which agricultural households judge their achievements and the multiple constraints and technological relationships under which they operate, as well as the several challenging tasks of aggregation…" Consequently, many researchers shy away from undertaking studies that attempt to analyze total farm interactions and their impact on the farm household.

Another difficulty facing impact studies is the difficulty in establishing cause and effect and isolating costs and benefits from a number of contributing factors. Furthermore, the application of a technology is only one of many factors influencing farm incomes including support services and pricing policies. This is particularly true in agricultural development programs in which technology is usually developed for a certain "environment" and

is then used in a different "environment" with stronger support services and positive price policies. The influence of contributory factors may be more critical than the technology itself in certain conditions.

Some of the more common methods used to study impact are the case studies approach, before and after approach, and the with and without approach. All the above studies are exposed in nature.

The case study approach studies individual farmers or specific groups of farmers in depth to identify the different components that are strong or weak in the adoption/non-adoption of a technology. Once a representative farmer or group is identified, long-term monitoring could provide adequate data for in-depth analysis to determine factors explaining the adoption of certain activities. This approach is relatively cheap and of shorter duration and does not warrant complex methodologies for analysis. It is easily implementable and, if appropriate indicators are identified, very useful.

The "before and after" as well as the "with and without" approaches are commonly used in project evaluation. Generally, they are used with large-scale projects with external funding in order to assess the performance of the project rather than to consider adoption or non-adoption of a given technology. Both of these approaches need adequate baseline data. Hence, evaluation procedures must be built into the project planning and design.

In dealing with the small farmer sector, where most agricultural households produce commodities primarily for home consumption and marketable surplus is low, determining real benefits are difficult. Hence the traditional benefit-cost or internal rates of return measures tend to be meaningless. It is, however, possible to adapt the two approaches in order to study impact of agricultural technology being used by farmers. An important basic indicator is information on "adoption." Another is the time framework since "adoption" of the technology. Adoption of successful technology tends to follow a significant curve with initial effect showing up in the first 2 to 3 years but the full impact not being experienced for 7 to 10 years.

Methodologies Used

Up to now, a common tool for analysis used by researchers involved in impact analysis is cost and returns using a partial budgeting technique. It is simple, easily understood and could be carried out by researchers at the study sites. It has been used extensively by Price (1982) in the Philippines and Ranaweera (1983) in Sri Lanka. A more complicated approach has been used by Wangwacharakul (1984) using an input-output model to study impact of new technology and irrigation in the economy of two provinces in Iloilo in the Philippines, considering output, incomes, imports and employment, while Mathema (1986) used production function analysis to analyze the impact of cropping systems research in Nepal. Production functions have also been used to measure frontier performance and technical efficiency in Sri Lanka by de Silva and Shand (1986) between innovative and non-innovative farmers. While production function analysis provides a good method to differentiate between adopters and non-adopters of new technology, it suffers from the drawback of not providing an insight into the relative well being of the two populations, capturing all the effects of a whole farm.

This could theoretically be overcome by using linear programming (LP) techniques. Jayasuriya and Price (1980) enumerated a number of advantages of LP techniques in analyzing whole farm data over others and also discussed some of the difficulties in dealing with assigning values to certain parameters. Barlow et al. (1983) used an LP framework to analyze the impact among selected individual farms at two cropping systems sites in the Philippines that included consumption variables. The study suffered from the drawback that it was only single period. To be realistic, though, the program needed to accommodate the dynamic nature of all farm and non-farm activities over time, as well as consider aggregation across a number of farms, in order to be able to provide an estimate of its effects from a macro sense even to the specific environments. If all household activities adequately captured, in a theoretically consistent manner, can be subjected to empirical applications that then could be used for developing strong policy interventions, the acceptance of the new technology could be further improved, and the potential benefits could be obtained.

In modeling agricultural households, it is necessary to combine the farm with the household. A number of empirical models to analyze farm-household effects have been developed over the years. They help identify the size of the marketed surplus and the demand for non-agricultural goods and services and measure a certain degree of welfare among farm households (Singh et al., 1986).

Major econometric and estimation issues arise in the development and analysis of farm household models. Most of the production and consumption models that involve decision making are considered simultaneous over time, and can be analyzed recursively. However, such analysis requires considerable time and a fair degree of sophisticated analytical capabilities.

+There are many approaches to studying the farm household models. AU this notwithstanding, the essential
lesson is the need to combine the production and consumption decisions. The mode of econometric analysis then becomes a secondary issue.

THE ILOILO IMPACT EVALUATION

For this study, a simplistic analytical model can be stated as follows, which incorporates all components of the farm and household.

$$TI - I_t + I_o + I_s$$

where

TI - total income
I_t income from farm due to technology
I_o = income from off farm activities
I_s = income from other sources

If $I_t > I_o$ and $I_t > I_s$, then income from farm activities predominates.
If, however, $I_t \leq I_o$ and $I_t \leq I_{s>}$ the income from the farm could then be not significant.
In two populations of adopters and non adopters, if I, (adopter) $\leq I_t$ (non adopters), then the new technology has little effect on farm income.
Additionally, a welfare function can be developed as follows.

$$W = f\ (I, E, C, S,)$$

where

W = welfare of farm family
I = total income
C = consumption
E = educational level
S = savings

The individual relationships can further be stated as follows.

$$I = f\ (I_t,\ I_o,\ I_s)$$
$$C = f\ (I, E, S)$$
$$E = f\ (I, S)$$

The model that is simultaneous in nature can be solved recursively and a measure of total welfare between the two groups determined.
For the purpose of this paper, however, analysis is restricted to examining performance between adopters and non adopters as well as of the farmers before and after, using partial budgets and production criteria. An analysis of differences in consumption patterns between the two groups is also made.

Study Area

The study area is at Oton and Tigbauan municipalities in Iloilo Province where the original cropping systems studies were undertaken from 1975-80 (Fig. 3). The technology developed was under rainfed conditions, and, therefore, only rainfed areas were considered for the impact study. A sample of 60 farmers was selected, some of whom were those in the original program.
The site is a typical farming village where infrastructures are trimmed to the basic, e.g. all-weather road, small-scale grain mills, buying station, elementary school, etc.

rainfed lowland. Land tenure in the area has shifted from share tenancy in 1975 to leasehold in 1987 (Table 1). Farm power now is dominated by small power tillers and motorized rice threshers when before carabaos were the only source of draft power.

Study Method

A combination of the "before and after" and "with and without" approach was used for the study. The original baseline data that were available from 1975-80 were used. Since some of the data were incomplete and 1977-78 had the best data set, 1977-78 was chosen as a base year and compared with 1987-88.

The adopter/non-adopter method as a proxy for "with and without" was also used in the study. It was not possible to determine these two groups at the start of the project because of the difficulty in categorization. Differentiation between these two groups was done after the monitoring period. The farmers' performance was measured using scores assigned to each component technology.

The set of recommendations developed during the research phase was used in determining farmer's adoption level. These are specified levels and kinds of inputs, time of application, cut-off planting dates, varietal usage and crops in sequence.

In this study the following weights were used:

Criterion	Weight
Three-crop sequence	5
Two-crop sequence	5
Use of HYV	2
Planting within cut-off date	2
N = 60 kg/ha or more	1
P = 30 kg/ha or more	1
K = 60 kg/ha or more	1
Basal fertilizer application	1
Basal + top dress application	1
Total score	19

These criteria and weights were applied for each plot, and the total score weighted by its area. The total score of all the fanner's plots was used to determine his level of adoption. A cut-off score of 8 was used, i.e. fanners with a score of 8 or below were considered non-adoptors.

Analytical Methodology

Production aspects were analyzed using production analysis, and the consumption levels were compared between the two time periods (1977-78 and 1987-88) and the two groups, using "t" tests. All monetary values were at constant 1987 prices.

The analysis is presented first on a before and after basis and later between adopters and non-adopters for the production and consumption aspects.

Data Collection

The method of data collection used during the 75-80 and the 87-88 period were basically the same. A baseline survey was done using 200 respondents in 1975. From this population 45 farmers were randomly picked to composed the "economic cooperators."

In the 1987 study, 60 farmers were randomly selected from a master list of farmers in the area. An inventory of these selected farmers that considered all farm-household assets was taken.

In both periods these farmers kept records of their daily farm activities as well as the farm-household cash flows. The Held assistants, in turn, collect this information on a weekly basis.

Tenurial Arrangements

Table 1 indicates the changes in tenure status between 1977 and 1987. The percentage of owner cultivators among adopters is double that of non adopters. Share tenancy has been reduced considerably among both adopters and non adopters.

Farm Equipment Ownership

Table 2 summarizes the farm power and farm equipment distribution between the two groups. This provides an approximate estimate of the purchases of assets for farm use. Adopters generally tend to have more farm power and other equipment than non adopters, particularly hand tractors and sprayers.

Production Activities and Yields

Table 3 outlines the changes in cropping patterns over the period 1977-1987. In 1977 the significant pattern was rice-fallow (90%), which has gone down to 31% in 1987 among adopters. The differences between adopters and non adopters are not significant if cropping patterns alone are considered. The new technology, which is a rice-rice or rice-other crop, has increased from 8% in 1975 to 66% among adopters in 1987. In 1987 the pattern was being accepted by 71% of non adopters as well. High-yielding varieties that were used by only 30% of farmers in 1977 had increased to 100% in 1987 for both groups.

A comparison of agricultural production activities between the 10 years shows differences in input and labor use. There is no significant difference in labor use for many of the operations except for weed control in the first season and for land preparation and crop establishment in both the first and second crop of rice (Tables 4 and 5). Labor for land preparation and crop establishment was reduced. This is explained by the change in cultural practice from transplanted rice to dry seeded rice, which is labor reducing but costs of weed control are higher.

Use of material inputs has also changed significantly. The total quantity of N fertilizer increased by 116% for the first crop and 97% for the second crop over the two periods. There are significant increases in P and K fertilizers as well.

Yields have increased substantially. The yield in 1977-78 of 1.613 tons/ha has increased over 240% to 4.018 tons/ha during the first crop season. During the second season the increase is not that remarkable but is still significant from 1.415 tons/ha to 2.438 tons/ha (an increase of 72%). This could be attributed to the increased use of input levels, particularly fertilizer, as well as better crop management techniques. From an agronomic point of view, the use of increased input levels is providing the anticipated higher yields.

Considering the performance of adopters and non-adopters (Table 6 and 7), the former use more inputs in the first crop, particularly fertilizer application (P is significant at 1% level, while N at 5% level). The total number of man hours is also significantly more for adopters than for non adopters. Input levels for the second crop also are higher for adopters, particularly in the use of N_2 fertilizer.

Analysis of yield data indicates that adopters perform significantly better in the first crop (4.309 tons/ha as against 3.922 tons/ha for non adopters). However, second crop yields do not show significant differences between the two groups.

It is the general practice that farmers in Iloilo have more inputs and effort during the first season in which they feel they have greater chances of success than for the second crop. Hence the non-significant differences between the two groups during the second season are not surprising.

Cost and Returns

An analysis of the costs and returns of the two crops between 1977/78 and 1987/88 provides interesting insights. Tables 8 and 9 illustrate the changes in net returns that have taken place. During the first crop, yield increases were significantly different, and so were the total variable costs. Higher labor costs were observed in 1987/88 for harvesting and threshing while lower labor costs were seen for land preparation and crop establishment. However, differences in net returns are not significant. In fact, the real price of paddy decreased from US$0.33 (pesos 6.71) in 1977 to US$0.178 (pesos 3.50) per kg. This decrease of almost 48% in the real price of paddy negates any gains in the almost 250% increase in yield that was obtained by the farmers.

In the second season, the total variable costs were not significantly different, even though costs for land preparation were lower and costs for threshing higher. A decrease in net income of US$69 was observed in 1987, though this was not significant. Here again the price decreased from US$031 (pesos 6.18) in 1977 to US$.16 (pesos 3.30). Once again farmers have increased yields with better management, but real incomes remain unchanged.

Analyzing the costs and returns of adopters and non adopters in 1987/88, there are no significant differences in either variable costs or in the net returns (Tables 10 and 11). There was a marginal difference in cost in the first season (US$3.00) and in the second season (US$9.00). Prices obtained by the two groups for paddy were nearly the same. Overall, however, adopters have a slightly higher income.

The above analysis raises questions regarding the procedures for classifying adopters and non adopters. In any given cultivation year, from a technology use point of view, there is very little difference in performance between these two groups.

Farm Household Cash Flow

A comparison of farm income-cash flow between the two periods shows a significant difference in the total cash balance in 1987/88 (Table 12). Income from rice sales (essentially income from the farm) was more in 1987-88 than ten years earlier, and the difference is significant at the 1% level. This is reflected in the drop in rice prices between the two periods. Income from poultry/livestock sales is significantly higher, and other sources of income, including remittances, are high. Wages as a source of income have decreased.

On the expenditure side, total farm expenditure in 1987/88 was low. However, expenditure on hired labor was significantly less. This was related to the change in the technology as mentioned earlier.

In household expenditure, farmers spent more on food (significant at 1% level) but less on miscellaneous expenses such as personal clothing, gambling. Educational expenses in 1977/78 were higher than in 1987/88. Overall, farmers have more savings at present than in 1977/78.

Analyzing the 1987/88 data between the adopters and non adopters shows that adopters have significantly higher incomes and expenses. Income from sales of rice, poultry and livestock are significantly higher. Adopters spend more on food and other miscellaneous expenses.

DISCUSSION

The study surfaced a number of interesting issues, which are pertinent both from a policy as well as a methodological point of view.

1. It is apparent that the technology developed for the rainfed environment at the research site is technically sound and adopted to a large extent by the farming community. While HYV use is universal, other components may have been partially adopted.
2. Due to its technical superiority, the yields obtained by the farmers were significantly higher even 10 years after the technology had been introduced. Labor costs have gone down for the major operations (land preparation and crop establishment) in keeping with the requirements of the new technology. Harvest labor costs are high due to increase yield.
3. Variable costs to produce the new technology are higher. However, the real net income obtained is significantly lower and in the second season of 1987/88 less than 10 years earlier. This is directly attributable to the decrease in price of paddy by almost 48%. The gains from increased yields, therefore, are negated. This underscores the need to consider agricultural prices as a policy measure to ensure continuing increased incomes to farmers. Price supports or subsidies need also to be considered within the perspective of increased production by use of new technology. In this analysis no adjustments were made to payments by the farmers of landlord shares. If this be included, all tenant farmers would have negative incomes.
4. From a methodological point of view, analyzing data between time periods poses no problem, provided the earlier data set is reasonably complete and accurate. However, in categorization between "adopters" and "non adopters," a fair share of ambiguity arises. The study surfaced the following issues.
   a. Categorization of farmers into adopters and non adopters based on a single year's performance leaves the distinction unclear. There were no significant differences in either input use or yield. It is difficult to capture the perception a farmer has of profitability of the technology as well as his resource use. Availability of capital at critical periods also determines his decision making process as does his own perception of risk. Consequently an "adopter" in a particular season or year can be a "non adopter" the next year. Therefore, categorization on a scale of 0-1 should be avoided. What may be desirable is to have a range of adopter-non adopter farmers and consider performance on a differential scale. It is necessary to further investigate this aspect over a 2-3 year study period.
   b. The use of weights to determine the two groups also poses problems. A major issue in this exercise is the assignment of weights for each criterion. Should each criterion carry equal weights? Or should weights be pro-rated to emphasize their importance? The close interrelationship of the factors (criteria) likewise makes judgment of their importance more complex. One can, therefore, come up with a wide range of weights assignment, and each is as good as the other depending on the argument used.

c. Determining the links between income and expenditure as well as understanding the relative significance
of the different income sources is difficult. Aggregation across individual farmers also poses a major issue because resource bases are different and decision making processes vary.
d. A possible compromise would be to consider a sizeable number of case studies subjectively determined to represent different categories but reflecting farm sizes, tenure and any other identifiable parameter.

CONCLUSION

The need to incorporate policy perspectives into development of FSR technology is evident. While technology per se is acceptable, the lack of policy interventions has negated a large portion of the gains in productivity.

More research is needed to determine the methodological aspects that consider the categorization of adopter and non adopters. There is no clear distinction between the two when dealing in studying the impacts of agricultural technological that is agronomic in nature.

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Table 1. Changes in tenurial status.

	1977	1987	
Tenurial type	All Farmers	Adopter	Non adopter
Owner cultivator	28.0	60.0	30.0
Leaseholder	33.4	20.0	35.0
Share tenant	29.1	17.5	4.0
Amortized	3.5	2.5	-
Land/others	13.5	-	20.0
Total	100.0	100.0	100.0

Table 2. Farm power and other equipment

	1977	1987	
Equipment	All Farmers	Adopter	Non adopter
Buffalo (no.)	48	33	23
Hand tractor (no.)	-	5	2
Mechanical thresher (no.)-	4	3	
Hand sprayer (no.)	36	27	14

Table 3. Shifts in cropping pattern and use of rice varieties.

	1977	1987	
Cropping Pattern	All Farmers	Adopters	Non adopters
% farm			
R-F	90.0	31.0	29.0
R-R	4.0	46.0	45.0
R-OC	4.0	20.0	26.0
OC-OC	2.0	3.0	-
TOTAL	100.0	100.0	100.0
% extent			
TV 1ST CROP	70.0	-	
TV 2ND CROP	-	-	
HYV 1ST CROP	30.0	100	100
HYV 2ND CROP	-	100	100

R-F = Rica - Fallow
R-R = Rica - Rica
R-OC = Other crops - Other crops
OC-OC = Other crops-Other crops
TV = Traditional varieties
HYV = High yielding varieties

Table 4. Input lavais and yield of first crop rice, Oton-Tigbauan, lloilo), Philippines.

Input	Unit	1977-78	1987-88	Difference
No. of observation		158	167	
Yield	kg/ha	1613	4018	2405***
Labor and Power				
Nursery operation	mh/ha	4	4	0
Land preparation	mh/ha	139	97	-42***
Crop establishment	mh/ha	88	16	-72***
Fertilizer applic.	mh/ha	7	8	1
Insect control	mh/ha	8	8	0
Weed control	mh/ha	31	68	37***
Other crop care	mh/ha	0	2	2
Subtotal		277	203	-74
Materials				
seeds	kg/ha	103	178	75*
N	kg/ha	36	78	42***
P	kg/ha	2	24	22***
K	kg/ha	2	4	2

*** significant at 1% level
** significant at 5% level
* significant at 10% level

Table 5. Input levels and yield of second crop rice, Oton-Tigbauan, Iloilo, Philippines.

Input	Unit	1977-78	1987-88	Difference
No. of observation		111	89	
Yield	kg/ha	1416	2438	1022***
Labor and power				
Nursery operation	mh/ha	2	8	6*
Land preparation	mh/ha	113	66	-47***
Crop establishment	mh/ha	69	34	-35***
Fertilizer application	mh/ha	8	7	-1
Insect control	mh/ha	8	11	3
Weed control	mh/ha	13	10	-3
Other crop car*	mh/ha	0	3	3
Subtotal		1740	2666	926***
Materials				
Seeds	kg/ha	102	184	82***
N	kg/ha	34	67	33***
P	kg/ha	4	16	12***
K	kg/ha	1	1	0

*** significant at 1% level
** significant at 5% level

Table 6. Input levels and yield of first crop rice, Oton-Tigbauan, Iloilo, Philippines, 1987-88

Input	Unit	Adopter adopter	Non-	Difference
No. of observation		92	62	
Yield	kg/ha	4309	3922	387*
Labor and power				
Land preparation	mh/ha	102	94	8
Crop establishment	mh/ha	12	18	-6
Fertilizer applic.	mh/ha	9	7	2
Insect Control	mh/ha	8	6	2
Weed control	mh/ha	107	22	85***
Other crop care	mh/ha	2	1	1
Subtotal		240	148	92***
Materials				
Seeds	kg/ha	175	196	-21*
N	kg/ha	84	69	15*
P	kg/ha	29	17	12***
K	kg/ha	7	0	7

*** significant at 1% level
** significant at 5% level
* significant at 10% level

Table 7. Input levels and yield of second crop rice, Oton-Tigbauan, Iloilo, Philippines, 1987-88

Input	Unit	Adopter	Non-Adopter	Difference
No. of observation		55	30	
Yield				
	kg/ha	2554	2248	306
Labor and power				
Land preparation	mh/ha	69	64	5
Crop establishment	mh/ha	17	32	-15
Fertilizer application	mh/ha	8	6	2
Insect control	mh/ha	10	12	-2
Weed control	mh/ha	13	6	7
Other crop care	mh/ha	5	0	5
Subtotal		122	120	2
Materials				
Seeds	kg/ha	180	197	-17
N	kg/ha	76	51	25***
P	kg/ha	17	16	1
K	kg/ha	1	0	1

*** significant at 1% level

Table 8. Partial budget (US$/ha) of first crop rice, Oton-Tigbauan, Iloilo, Philippines[1]

Items	1977-78	1987-88	Difference
No. of observation	189	167	
Yield	1613	4018	2405***
Labor and power			
Nursery operation	1	2	1
Land preparation	43	14	-29***
Crop establishment	14	3	-11***
Fertilizer application	1	2	1
Insect control	2	2	0
Weed control	4	10	6***
Other crop care	0	0	0
Subtotal	65	33	-32***
Harvesting	57	76	19***
Threshing	39	69	30***
Subtotal	96	145	49***
Materials			
Seeds	30	32	2
Fertilizer	26	43	17***
Herbicide	0	1	1
Insecticide	4	6	2
Subtotal	60	82	22***
Total variable cost	221	260	39***
Gross returns	538	704	165
Net returns	317	444	127

*** significant at 1% level
** significant at 5% level
* significant at 10% level

Exchange rate: $1.00 = 20.00

[1]Based on 1987 prices

Table 9. Partial budget (US$/ha) of second crop rice, Oton-Tigbauan, Iloilo, Philippines.[1]

Items	1977-78	1987-88	Difference
No. of observation	111	88	
Yield	1415	2438	1023***
Labor and power			
Nursery operation	0	3	3
Land preparation	46	13	-33***
Crop establishment	14	7	-7*
Fertilizer application	1	2	1
Insect control	2	4	2
Weed control	2	3	1
Other crop care	0	1	1
Subtotal	65	33	-32***
Harvesting	49	70	21
Threshing	20	60	40***
Subtotal	68	130	62**
Materials			
Seeds	28	26	-2
Fertilizer	27	32	5
Herbicide	1	0	-1
Insecticide	4	6	2
Subtotal	60	64	4
Total variable cost	193	227	34
Gross returns	437	402	-35
Net returns	244	175	-69

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Exchange rate: $1.00 - 20.00

[1] Based on 1987 prices.

Table 10. Partial budget (US$/ha) of first crop rice, Oton-Tigbauan, Iloilo, Philippines, 1987-88.[1]

Items	Adopter	Non-adopter	Difference
No. of observation	92	62	
Yield (kg/ha)	4309	3922	387***
Labor and power			
Land preparation	16	11	5***
Crop establishment	3	4	-1
Fertilizer application	2	2	0
Insect control	2	2	0
Weed control	16	4	12***
Other crop care	0	0	0
Subtotal	39	23	16***
Harvesting	78	82	-4
Threshing	61	83	-22*
Subtotal	139	165	-26
Materials			
Seeds	32	35	-3
Fertilizer	50	34	16***
Herbicide	1	1	0
Insecticide	6	6	0
Subtotal	89	76	13***
Total variable cost	267	264	3
Gross returns	586	518	68*
Net returns	319	254	65

*** Significant at 1 % level
** Significant at 5% level
* Significant at 10% level

Exchange rate: $1.00 = 20.00

[1] Based on 1987 prices

Table 11. Partial budget (US$/ha) of second crop rice, Oton-Tigbiauan, Iloilo, Philippines, 1987-88.[1]

Items	Adopter	Non-adopter	Difference
No of observations	55	30	
Yield (kg/ha)	2554	2248	306
Labor and power			
Land preparation	13	12	1
Crop establishment	4	11	-7
Fertilizer application	2	2	0
Insect control	4	4	0
Weed control	4	1	3
Other crop care	2	0	2
Subtotal	29	30	-1
Harvesting	53	58	-5
Threshing	47	38	9
Subtotal	100	96	4
Materials			
Seeds	25	28	-3
Fertilizer	35	27	8
Herbicide	0	0	0
Insecticide	6	5	1
Subtotal	66	60	6
Total variable cost	196	186	9
Gross returns	411	391	20
Net returns	216	205	11

Exchange rate: $1.00 = 20.00

[1] Based on 1987 prices

Table 12. Farm-household cash flow (US$), Oton-Tigbauan, lloilo, Philippines.

Items	1977-78	1987-88	Difference
No. of observation	45	49	
Farm income			
Rice sale	556	478	-78***
Household income			
Poultry/livestock sale	122	188	66***
Wages	77	52	-25
Loan proceeds	98	42	-56
Remittances	166	233	67
Other incomes	121	165	44
Subtotal	584	680	96
Total income	1140	1158	18
Farm expenditure			
Hired labor	49	28	-21***
Fertilizer	96	97	1
Chemicals	29	27	-2
Equipment rental	84	62	-22
Other expenses	35	5	-30**
Subtotal	293	219	-74
Household expenditure			
Food	232	307	75***
Poultry/livestock	34	25	-9
Loan repayment	74	34	-40
Education	125	84	-41
Other expenses	383	266	-117***
Subtotal	848	716	-132
Total expenses	1141	935	-206
Cash balance	-1	233	224***

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Exchange rate: $1.00 = 20.00

Table 13. Cash flows of adopters and non-adopters (USS/household), Oton-Tigbauan, Iloilo, Philippines, 1987-88.

Items	Adopters	Non-adopters	Difference
No. of observation	28	21	
Farm income			
Rice sale	758	287	471***
Other crop sale	29	17	12
Other farm income	31	47	-16
Subtotal	818	351	467***
Household income			
Poultry/livestock sale	333	194	139***
Wages	72	48	24
Loan proceeds	53	27	26
Remittances	281	208	73
Other incomes	167	122	45
Subtotal	906	599	307**
Total Income	1724	950	774***
Farm expenditure			
Hired labor	32	23	9
Fertilizer	111	79	32*
Chemicals	33	19	14
Equipment rental	79	40	39
Other expenses	8	2	6**
Subtotal	263	163	100
Household expenditure			
Food	381	294	87***
Poultry/livestock	31	18	13
Loan repayment	47	19	28
Education	99	75	24
other expenses	278	209	69**
Sub total	836	615	221***
Total expenses	1099	778	321***
Cash balance	625	172	453**

*** Significant at 1% level
** Significant at 5% level
* Significant at 10% level

Exchange rate: $1.00 - 20.00

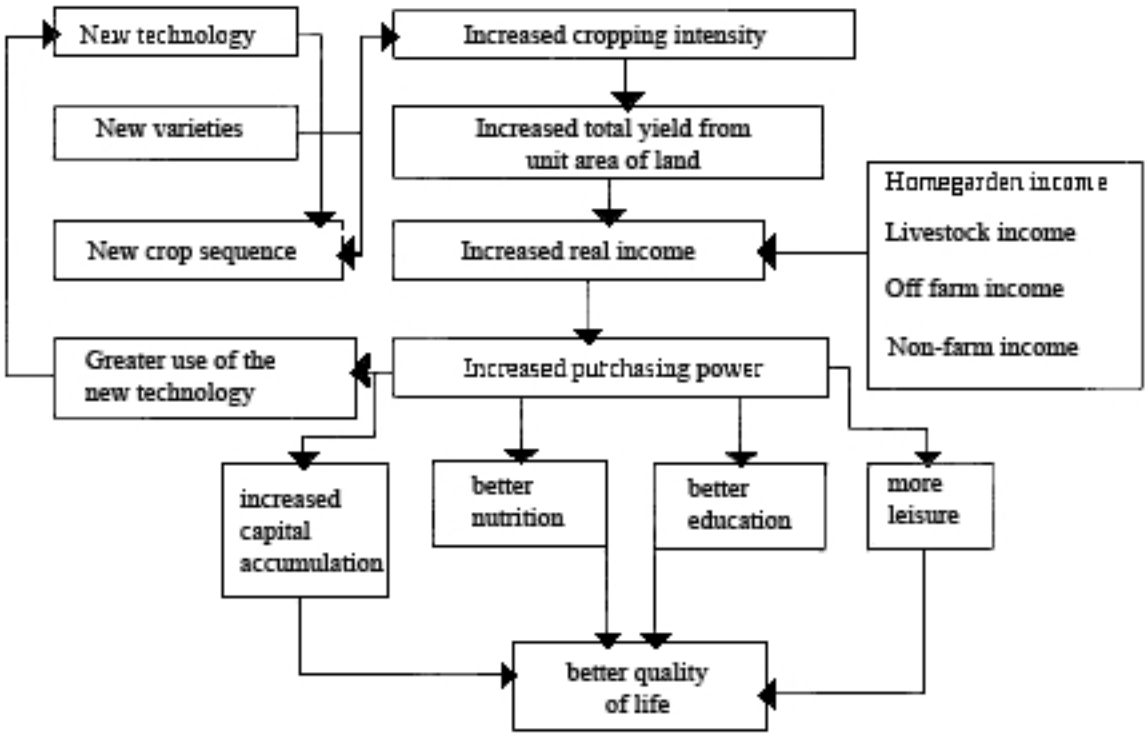

Fig. 1. Schematic.

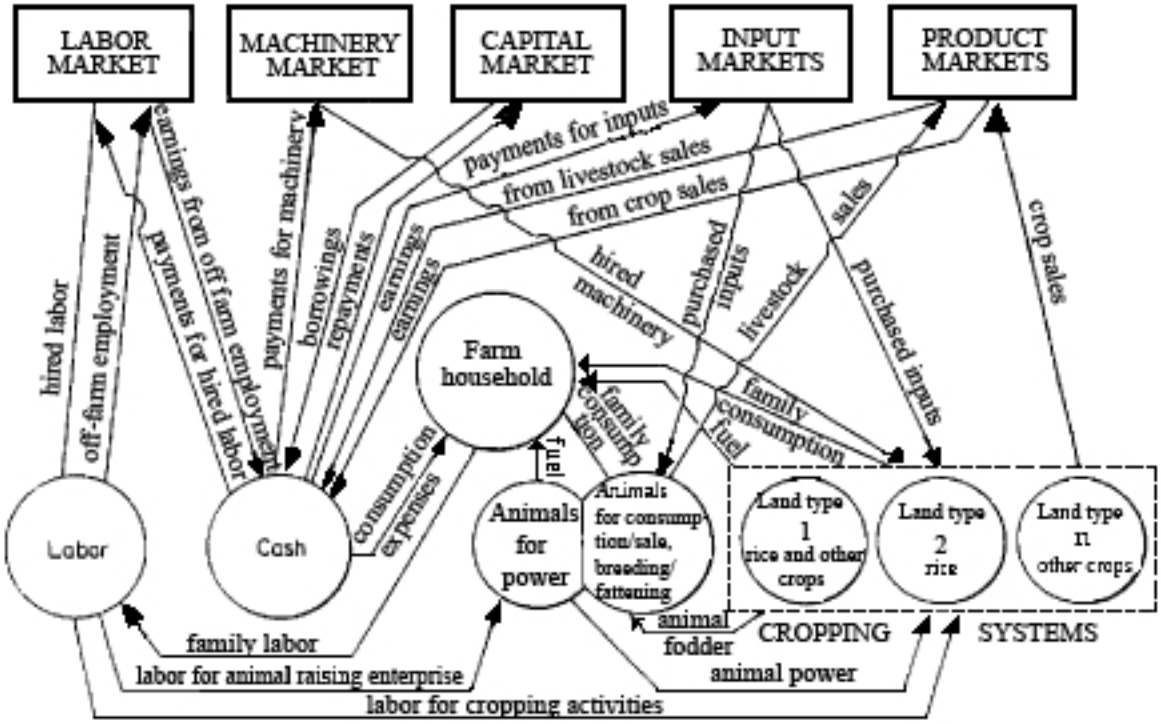

Fig. 2. Resource flaws in the farming system.

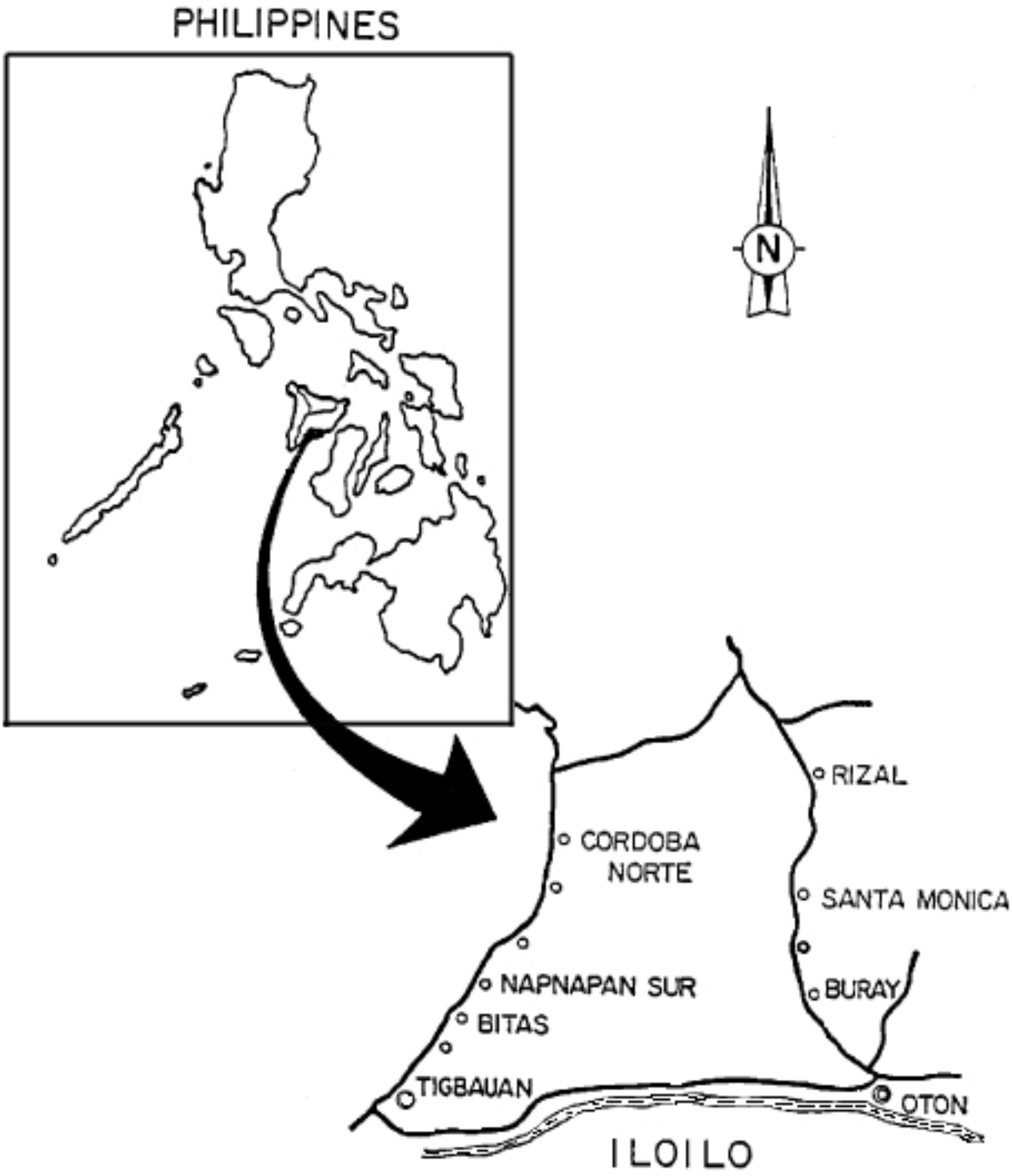

Fig. 3. Map of study area in Iloilo, Philippines.

Latin American Regional Papers

THE PARTICIPATION OF WOMEN AS A "USER GROUP" IN TECHNOLOGY GENERATION FOR SMALL FARMERS IN LOW-INCOME COUNTRIES

Jacqueline A. Ashby[1]

INTRODUCTION

Neglect of the users' point of view in technology design can be costly and inefficient. Little or no adoption occurs because technology is not suitable for significant groups of intended users; or if adopted, technology often has an unanticipated adverse impact on intended beneficiaries. Such problems were seldom of concern in agricultural research before its institutionalization in the nineteenth century in the developed countries. Then, technology design was the domain of the farmer-inventor. For a short time farmers continued to have an active say in defining research agenda as institutional capacity developed. Today, the supply of technology generated by public sector agricultural research systems for low-income countries is largely defined by the scientific community in interaction with policy makers.

It is now generally recognized that agricultural research oriented at serving disadvantaged populations in unfavored agricultural areas entails solving difficult problems and requires much situation-specific adaptation. Essential to effective use-oriented research is an understanding of the needs and constraints faced by potential users who have little access to formal channels of communication with the scientists, research managers and policy makers who determine research agenda. On-farm research and farming systems research programs were widely promoted over a decade ago to address the need to differentiate "special user groups" among the farm population and to assess technology in terms of its appropriateness to their special needs.

However, as the definition of user-group becomes more refined or segmented (to include consideration of gender issues, for example) there is concern that fanning systems research requires resources and management skills that may outstrip the current capacity of agricultural research systems, both international and national. This raises a key question for discussion of the implications of differential user impacts for the research process:

How can public sector research organizations serving poor farmers in developing countries institutionalize rapid feedback to technology designers from their clients?

The central issues for agricultural research implied by this question are as follows:

- how to identify and set priorities among different client groups who are often powerless to communicate their needs?
- how to diagnose the needs, goals and constraints of particular groups and assess the potential impact of different technological options on these?
- when in the research process to integrate information about client groups and their needs so as to orient technology choice and design?
- how to allocate and institutionalize responsibility for identifying, prioritizing and responding to client needs in the research process.

The objective of this paper is to review these issues, with specific reference to gender, focusing on the questions of when and how in the agricultural research process the implications of differential user impact should be accommodated. The intent is to raise issues towards discussion of appropriate strategies for client-oriented research and, in particular, women as users of agricultural technology. The paper proceeds with an overview of what is understood by user groups and technology impact in order to provide a framework for discussion of the implications of gender issues for different stages in the research process.

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USER GROUPS, TECHNOLOGY AND IMPACT IN RELATION TO GENDER

Who the users are and what types of impact have to be considered in the process of technology generation are important for analysis of the different stages in the research process when attention to dient needs may be critical to achieving the stated goals of the research system.

Special user groups are implicitly identified by three main objectives of international research on agricultural technology for developing countries defined as follows:

- to increase the amount, quality and stability of food supplies in low-income countries.
- to contribute to meeting nutritional requirements of less-advantaged groups in low-income countries.
- to take into account income generation and the standard of living of the less-advantaged, which determines their access to food and equity in the distribution of benefits from research.

Within these terms of reference, potential users or client groups can be defined to include small farmers, tenant farmers (the semi-landless) landless laborers, low-income consumers (rural and urban) and the malnourished (rural or urban). Evidence is accumulating that priorities for technology adoption and thus for research are likely to vary within households in any one of these social strata. The model of the male-headed family making decisions to maximize a uniform family welfare function, where a common set of objectives are maintained and benefits are equitably shared among household members, no longer appears adequate for the definition of clientele for agricultural research.

Without the intervening mechanism of the market to signal the relative importance of different client groups among and within households in developing countries, special research must often be undertaken even to identify their existence. Women, the "invisible farmers" of the Third World, are a case in point. However, it is important for this discussion to bear in mind that gender is only one variable, albeit a highly significant one, among several that merit consideration in sorting out intra-household variation in the impact of technology. Women are not a homogeneous client group, and gender cross-cuts the different social strata of user groups identified earlier. As potential users of agricultural technology, the interests of different groups of women diverge not only from those of men but from each other and may conflict.

There are also supra-household or community-level dimensions of technology impact that need to be considered in defining client groups for agricultural research. When resources such as irrigation water, forests, livestock herds or grazing land are managed in common or when externalities are important aspects of technology impact, such as soil erosion, water pollution or pest and disease control for livestock as well as crops, then focus on the community and the role of women in the community is needed.

The need to consider intra-household, including gender, as well as community-level variation in the impact of technology greatly complicates empirical definition of the universe of client groups for agricultural research.

Table 1 presents by way of example an overview of the potential impact of technology on rural women and implications for technology generation. In order to carry out this exercise for any given user group, their special circumstances need to be understood. As summarized under the heading "Rural Women's Work Roles and Time Allocation" in Table 1, women face incentive structures from those of men that influence acceptance and impact of technical change because responsibilities for work and time availability differ between the sexes; male and female control over resources such as land, labor and cash differ; and access to institutional resources also differs. The evidence is that technology choice and design can affect women's work loads as unpaid family workers, their labor productivity and their access to non-farm employment. Also affected may be women's ability to manage stable year-round food supplies, their preferences for desired food characteristics and their control over farm input, income and expenditures. Women's access to income from production or employment affects their ability to provide care, adequate nutrition, or education for other family members. In summary, several alternative impacts are possible, and because women cannot be treated as a homogenous interest group, a given technology may have a different impact on one group of women than on another. No one technological option shown in Table 1 is "good," "bad" or "neutral" except in relation to a specific situation or stratum of women and the specific impact that is viewed as desirable. Trade-offs may exist between achieving impact on production or employment generation or food security and nutrition for a given group or among different groups of women.

A TYPOLOGY OF RURAL WOMEN IN LATIN AMERICA

This section of the paper outlines a framework for distinguishing distinct groups among the approximately 53 million rural women in Latin America who can be viewed as potential users of technology or beneficiaries of technical change in agriculture. To provide a context for the issue of who benefits from technical change, it is important to recognize that most women in Latin America are urban residents (Table 2) and that rural women therefore represent a minority of potential beneficiaries in the region.

The 53 million rural women in Latin America can be divided into broad categories that combine gender-specific and class-related situations. Census estimates must be interpreted with caution, however; the figures in Table 3 indicate something of the magnitude of different categories of economic activity. Unpaid family workers represent proportionately the largest group of women workers in agriculture. The second largest group is "self-employed" women, which in some countries such as Bolivia reflects the importance of traditional marketing activities carried out by women. Women wage laborers, the third largest group, amount to approximately 22% of women employed in agriculture according to census definitions,

These figures provide a rough indication of the relative size of different groups, but not a sufficiently accurate one to provide guidelines in setting research priorities. This is particularly important because a more detailed characterization of different groups of women shows that these may have competing interests. Difficult trade-offs may be involved in designing with their needs in mind.

A topology of rural women must take into account three major variables that define their status: access to and control over land, time allocation and marital status. Figure 1 summarizes the major social class divisions, types of farm enterprise, and related labor relations that provide a framework for dividing rural women into distinct groups. In Fig. 1, women in the landed elite and middle class are assumed to be mostly absentee, part-time residents on farms and wives of farm managers. The following discussion is concerned only with women who are farm residents or laborers in the small farm sector.

Farm "Housewives"

These women are members of relatively prosperous families with smallholdings that engage in commercial crop production and own large enough farms to employ family labor year-round as well as to hire in seasonal wage labor. Women in this social group appear to spend most of their time on so-called domestic work, which includes post harvest processing, seed selection and storage, as well as tending food gardens and caring for livestock. They tend to do very little fieldwork. These women typically have an important managerial role in farm decisions although they may not visibly participate in farm work. While they may have little direct input into choice of technology, they are influential in deciding how resources are allocated among different enterprises of the household. One observes, for example, that education of children is an important priority for women and that women in prosperous families may want the family to migrate from isolated rural settlements to small towns where medical and educational facilities are better. Such preferences affect the objectives of the small farm organization and indirectly influence decisions such as technical choice. This group of women is significantly under-enumerated by census estimates of unpaid family workers.

Farm Domestic and Field Workers

These women are members of "subfamily" farms that do not generate enough income to support the family. Although the men work off-farm some of the time, the farm is still managed as a joint enterprise by husband and wife. Subfamily farms produce a mix of cash and subsistence crops, and women participate as unpaid family workers in field operations in addition to their usual domestic work. These women are most likely to have multiple work roles as subsistence food producers, laborers in cash crops, artisans involved in handicraft production and petty traders. Young women in particular from subfamily farms are likely to migrate to cities, leaving older women to run the farm, and they may send remittances to the family in the countryside. Women on these farms may be entrepreneurs, investing small amounts of capital in "new" crops such as vegetables, in small livestock or in marketing. It is among this group that women's time allocation considerations and expenditure preferences are likely to enter directly into decisions about agricultural technology on the small farm.

Women on "Minifundias"

These women belong to the "near-landless" class of cultivators in Latin America for which wage labor is the principal source of income and land may be only a means of subsistence food production, although a small amount of produce is marketed. In this situation, women who are members of a stable marital union take

charge of the farming and marketing of farm output while men are almost wholly employed off-farm. Agricultural production may be managed by these women as an extension of the woman's role in the food system with its principal objective to provide a year-round supplement to the family diet for which staples are purchased. However, these women are also likely to engage in wage labors as domestic help on wealthier farms, as migrant labor in planting or harvesting of certain crops, in handicrafts, in petty trading and in seasonal work in agro- industries. As a result, the subsistence food garden may be abandoned. Technical changes in agriculture are likely to be most significant for this group of women in terms of employment effects and their effect on the price of staple foods relative to wages.

Women Wage Laborers—the Female "Underclass"

This group of rural women is distinguished from the women from minifundias discussed above by their lack of stable access to land and in many cases the absence of a stable marital union. Consensual unions without legal ties between men and women are an accepted social institution in traditional Indian cultures in Latin America, viewed as a type of trial relationship (Gutierrez de Pineda, 1975). However, the traditional viability of this institution depended on a network of kinfolk that either insured that marriage took place once children were conceived or undertook their economic support Among the poorer rural social strata, such support mechanisms no longer function, creating an "underclass" of poor women who are in a more precarious economic position than women in stable marital unions or even male wage laborers. Members of the female underclass are impoverished widows, single mothers who have no access to land and illegitimate female children with no land rights (Borque and Warren, 1981). The absence of a male partner may effectively block a single woman from access to land because of inheritance customs or land reform legislation, which in some countries denies single and married women the right to their own parcels and assigns these to the head of the household or requires male authorization for a woman to administer property (FAO, 1979). Many such women are urban residents who go out into the countryside to find work (Garcia, 1980).

Survival strategies for landless rural women include migration to cities, prostitution, domestic service, agricultural fieldwork or pairing up with a man who can provide access to land. Biographical studies of such women suggest that investment in their children is the most compelling concern that motivates their decision making as members of an unstable agricultural producing unit (Borque and Warren, 1981; de la Rive Box, 1983). The implications of different female and male incentive structures for decision making in farm households based on unstable consensual unions or the frequency of such situations in rural areas has not been studied in Latin America outside the Caribbean. However, many authors suggest that this type of situation is an underlying factor in the "feminization of farming" when women are abandoned by men with a small parcel of land—to which the women has no legal rights—for their own support and that of the children.

In summary, rural women in Latin America can be differentiated into several distinct interest groups. Those directly involved in smallholder agriculture who are potential clients or "users" of technology are as follows:

1. Farm housewives who will evaluate benefits of agricultural technology in terms of its effect on their overall household expenditure patterns and desired life-style. These women will have an input into adoption decisions because of their influence on farm management objectives.
2. Farm domestic and field workers who will evaluate agricultural technology in terms of its direct effect on their time allocation as well as its implications for farm income and expenditures. These women may be influential in rejecting technology that requires additional work on the small farm unless it generates sufficient income to enable male family labor or hired labor to meet the need for more labor time. These women are also clients for low-input technology that can be integrated into the subsistence food garden without increasing labor inputs significantly**,**
3. Women on minifundies may also be clients for low-input technology compatible with the subsistence food garden, but they may benefit more from technical change in agriculture that increases the supply of food staples that they purchase, or that they would purchase if prices fell. This group, like landless laboring women, are most likely to be directly affected by the implications of technology for labor requirements in the small farm sector, which may increase or decrease their employment opportunities.

The interests of different groups of women in terms of agricultural technology development are not, therefore, necessarily congruent—in some instances they may directly conflict. Determining just what these interests are and the relative importance of the different groups of women they represent are critical issues that must be addressed in order to determine the relevance of gender as a criterion for technology research and development. What then does this imply for different stages of the research process?

STAGES IN THE RESEARCH PROCESS

The research process for agricultural technology generation that takes place at a global level in public sector institutions can be divided into four stages (see Fig. 2):

1. Identification of overall goals or objectives. Priorities are set between commodity and factor-oriented research, among commodities and geographical regions. Either explicitly or implicitly in choice of commodity and region potential beneficiaries are targeted.
2. Problem identification, when the major constraints to be worked on for the commodities and regions selected are defined.
3. Strategy formulation, when priorities are set among problems, to devise research plans. These determine the approach to problem solution; the organization of research teams or projects; the different technology components requiring research; and the relative weight given to strategic vs. adaptive research.
4. Problem solution, when research methods and experiments are planned, technologies are developed and tested on-station and on-farm, to develop recommendations.

Priorities set in the first stage of the research process have important implications for differential impact on users. Such priority setting takes into account potential impact in relation to trade-offs between production vs. equity objectives, for example, or the relative impact to be obtained on aggregate production vs. employment and income generation or nutrition of the disadvantaged.

Gender and-Research Priorities

Assessment of the impact of technology has focused on adoption, neglecting the issues of how the poverty or affluence of different family members is affected. The assumption has been that production increases following adoption would necessarily create improved household welfare. However, the differential impact of adoption within households means that increased production, improved income generation or better nutrition for the less advantaged are not necessarily complementary in their impact.

There are important implications for overall research objectives of desegregating farm households as potential users and beneficiaries of research into different members, distinguished by sex and by age as well as by socioeconomic variables that describe their status as land owners or landless laborers, for example. Higher "household" incomes from increases in production in any given commodity do not necessarily translate into higher levels of welfare, in particular nutrition, for all members proportionately because of divisions of control over different commodities, livestock or other sources of farm income. The evidence is that income directly under women's control tends to be spent mainly on household needs with direct benefits to the nutritional status of the vulnerable (pregnant and lactating women and very young children). Even in quite high income classes, when the impact of technological innovation is to reallocate women's labor away from subsistence production or to assign control over output and income to men and away from women, the nutritional status of adult women, girls and very young children may actually decline, and they suffer higher rates of morbidity and mortality than males.

Although quantitative estimates are hard to come by, the evidence is that a significant portion of household food supply and household income in cash and kind may be generated by women and children through then-small-scale production of cereals, roots, pulses and seeds, vegetables and small animals and for domestic post-harvest processing. For example, in Nepal women contribute 54% of home production and 50% of income in cash and kind; in the Ivory Coast women provide 77% of household food supply, including 54% of calories and 38% of cash allocated to food purchases. A study in Peru finds women generate 30 to 40% of farm household cash income (Deere, 1983); another study shows that women provide up to 31% of weekly family earnings in two Filipino villages. Other studies show that small-scale marketing of fruits, vegetables, food products, small animals and livestock by-products by women and children is an important component of capital generation and savings on small farms.

The argument that gender is a factor in the amount, the quality and the stability of food production, as well as the access to food and nutritional standards of the poor, is based on causal relationships summarized in Fig. 3. Especially in the Latin American context, these causal relationships must be termed hypotheses, drawn from case studies in view of the extreme paucity of empirical research for Latin America that includes gender as a variable. This section of the paper reviews these relationships with particular reference to the available evidence from Latin America, with two objectives: (1) to provide a general analytical framework for the subsequent

discussion of women's participation rates in agriculture in the region and (2) to highlight the deficiencies in research that must be addressed in order to identify women as special user groups for agricultural technology.

Figure 3 outlines several features of structural change in Latin America that affect rural women's work roles on the farm and off-farm employment opportunities. The allocation of women's time among these different activities has implications for three important functions of the rural household (termed intervening variables in Fig. 3): the management of food consumption (food preferences); decision making roles in agricultural production and household expenditures; and for reproduction (child care and fertility). Gender affects the way in which these activities are organized within rural households, and these activities in turn influence the outcomes, shown in Fig. 3, which are of concern in specifying agricultural research objectives and strategy.

The relevance of gender to agricultural technology adoption and food production in the Latin American context must be assessed in the context of the dual structure of the agricultural sector. Salient features that affect rural women's work roles and time allocation are summarized in Fig. 1 under the heading of "structural changes in the rural sector." In brief, two major trends-the declining size and stagnant labor productivity of small farms, in tandem with modernization of the large-scale, capital-intensive estate and plantation sector—are seen as contributing to a process of "proletarianization" of small holders and near-landless minifundias. This process is significant for rural women's work roles in that it entails an increased dependence on off-farm earnings and the migration of surplus labor from the family farm (de Janvry, 1981; Deere and de Janvry, 1981; Garcia, 1980; Leon de Leal, 1980; Ossandon and Covarrubias, 1980; Jaquette, 1983).

Estates (haciendas) and plantations increasingly dispense with permanent laborers in favor of temporary wage laborers who often migrate from harvest to harvest. Some studies suggest that the resultant increase in underemployed male wage laborers has displaced women from what were once female tasks so that women have been increasingly relegated to the status of unpaid workers on family plots. The evidence is contradictory, probably reflecting local labor market situations in different Latin American countries, and different in sex-typing of agricultural tasks such as rice planting, coffee harvesting or cotton picking. For example, when temporary wage labor is paid by piece work, women and children are encouraged to join men in the seasonal labor force (Deere and Leon de Leal, 1982; Medrano, 1980; Garcia, 1980; Young, 1978; Sautu, 1979, 1980).

Traditional peasant agriculture in Latin America has been conventionally characterized as a prototype of the "male farming system" in which most of the field labor in agriculture is done by men (Boserup, 1970). However, the major thrust of recent evidence from micro studies is to show that a trend towards the "feminization of fanning" exists and that in general the participation of Latin American women in agricultural production has been substantially underestimated.

The de facto female-headed farm, where men are seasonal migrants or primarily engaged in off-farm labor, is an extreme case of the tendency for women to be more heavily involved in agricultural production activities as farm size decreases and as the importance of off-farm wages to household income increases (Buvinic et al., 1978; Deere, 1982). The magnitude of this trend for the region and its significance for farm management in the small-farm sector is impossible to estimate from available information. However, some important implications are indicated by micro studies of the "feminization of farming" for how rural women allocate their time and what this in turn implies for farm decision making and family welfare.

There are no published studies of rural women's time allocation for Latin America that enable one to provide an accurate estimate of how much time on a daily and annual basis is devoted to agriculture-related tasks, taking into account important regional, cultural and socioeconomic differences. However, it is widely stated in the ethnographic literature that the "domestic" work (food processing and cooking for field hands; gathering fuel and fetching water; cultivation of gardens and subsistence plots; care of small animals; and small scale marketing activities), which constitutes rural women's traditional work in Latin America, entails onerous, repetitive tasks that occupy most of their waking hours. There is some sparse evidence to suggest that as women's participation in agricultural field tasks as unpaid labor on family farms and as their employment as wage laborers increases, and as cash wages become the major component of household income, then women's time allocated to subsistence food production and food preparation declines. As women's time for domestic food production becomes a scarce commodity, food preparation preferences change in favor of purchased quick-cooking commodities that may be detrimental to nutritional standards, especially for children. For example, women substitute rice and wheat for coarse grains and legumes (Carloni, 1984; Stavrakis and Marshall, 1978). One study in Colombia found that subsistence "garden" plots tended by women were a feature of the better-off strata of small farms, not found among the very poorest farms (W. Janssen, personal communication).

Decreases in women's time allocated to managing subsistence food production and generating small amounts of cash may contribute to changes in patterns of household consumption because there are different male and female preferences for how expenditures are made. Many studies observe that farm products reserved for household consumption are traditionally managed exclusively in Latin America by women (Borque and Warren, 1981; Stavrakis and Marshall, 1978; Chayney, 1983; Deere and Leon de Leal, 1982). Women's time allocated to so-called domestic activities can involve a significant managerial input to determining the balance between subsistence and cash crop production on small farms and the balance of expenditures on food versus other goods. One study notes that women produce almost all food consumed by small farm families where men are engaged in cash cropping in Argentina (Sautu, 1979). Another found that patterns of intercropping were related to how women manage food consumption. The relationship between food supply from a woman's subsistence plot and from fields allocated to the cash crop affected the balance of secondary crops for household consumption intercropped with the main cash crop (W. Jansen, personal communication). Small-scale marketing and the feeding and selling of small animals are means of capital generation and savings on small farms. Observers have noted that this income can be viewed as "women's" income, used by women for incidental expenses of their children such as extra food, clothes, medicines, or school supplies (Schofield, 1979; Young, 1978). There have been no empirical studies that attempt to trace sources of income and expenditure in relation to gender in the rural household in order to document the relative influence of women's consumer preferences. Some studies of Latin cultural definitions of sex roles emphasize the complementarity of male and female work roles and how this entails mutual interdependence and power-sharing; others point out how men override women's preferences (see Borque and Warren, 1981, for review of this literature). Since both instances occur, it is dangerous to generalize about the influence of women's preferences in farm decision making.

The "feminization" of farming as men engage mainly in off-farm labor implies an increase in women's decision making over production inputs, including choice of technology. In one example in which survey research attempted to measure participation by sex in decisions about farm inputs, the incidence of women's decision making about farm input use did increase as farm size decreased (Deere and Leon de Leal, 1982). Findings from this study show that in "near-landless" and "smallholder" farms, women were the principal family members charged with decisions about what to plant, where and when in the majority of households. Only in the wealthier strata of farms was women's participation in such decisions restricted. The same pattern occurs among farm strata with respect to inputs. Women were the principal decision makers about seed and fertilizer inputs in 52% of the poorest farms and 27% of the wealthiest. Over 32% of households allocated the responsibility for inputs primarily to women, and women shared in these decisions in a further 35% of households. Studies of technical change in Latin American agriculture that attempt to trace choice of technique on the small farm to gender-related preferences are nonexistent, and such information of this nature that exists is anecdotal. However, rural women in Latin America do face different incentive structures from men, which may influence adoption of agricultural technologies on small farms where women influence decision making about input use.

Labor requirements of new technology have different implications for men than for women who do domestic tasks as well as agricultural field labor on the home farm, while men work off the farm. Some studies find that farm women in Latin America do not customarily contract hired labor and have difficulty in doing so or in exchanging labor with men (Deere and Leon de Leal, 1982; Borque and Warren, 1981). In several cases, hired labor appears to substitute for farm women's field labor rather than to complement it (Sautu, 1980). Hence poor farms where women of the family do field tasks and also play a significant role in management probably face stringent labor constraints that will influence male and female preferences for technical choice differently.

One study in the Caribbean observed a direct decline in agricultural production on female-managed farms as traditional male tasks were neglected: land went out of cultivation, terraces and irrigation systems deteriorated and production fell back into that level of subsistence manageable with women as a principal source of family labor (Chayney, 1983). Not only time availability but also the multiple nature of rural women's work roles may cause their preferences for farming techniques to differ from those of men. An example of this is given by Mintz (1964) who shows that a short-season bean variety was preferred by Haitian women farmers because it provided rapid turnaround on a small amount of capital that they would then invest in marketing other commodities at harvest time.

The access of a woman, in the absence of a husband, to credit, cash for purchased inputs and extension assistance tends to depend on her access to male kinfolk to mediate such transactions. For example, some credit systems in Latin American countries require both husband and wife to sign loan documents.

On the other hand, rural women in Latin America are more likely to find urban employment, albeit at very low wage rates, than men, and in certain groups, women have a higher rate of rural-urban migration than men

(Singh, 1980). The effects of different rural and urban labor market opportunities on male and female preferences in farm household resource allocation are not known, but one implication is that female preferences may tend towards the short-run as opposed to long-run investments in improving farm productivity (de Janvry, 1981; Elmendorf, 1976; Borque and Warren, 1981).

Research for Latin America on the causal relationships outlined in Fig. 3 is fragmentary and does not provide any basis for estimating the importance of gender-related effects on food production and welfare outcomes relative to other variables that also are related to technical change in agriculture.

In sum, women make a significant contribution to production, but this contribution is typically the sum of many apparently secondary activities that individually are less "visible" than male-dominated commercial crops, and the impact of women's production on a single crop or enterprise within the farm is usually relatively small. Women's direct contribution to food production, their role in managing food systems and their income generation intimately affect food availability in disadvantaged households through such activities as domestic food processing; small livestock such as sheep, goats, pigs and poultry; small-scale milk production; and home gardens. To the extent that these activities receive low priority in setting objectives for technology generation, then the welfare and nutritional status of women and children in poor households may be discriminated against in the research process.

Gender and Constraints Identification

Once objectives have been defined and priorities set among commodities and regions, the issue of differential impact on users has to be considered in defining which of the major constraints for the commodities and regions selected should be worked on. The extent to which problem definition is user-oriented or production- oriented determines the relative weight given to different constraints in formulating research strategy.

Most scientists and research managers in crop or livestock improvement programs think of problem identification in terms of biological production constraints; employment, income generation and nutrition of the poor are typically considered second order effects of improvements in production. This may not be adequate. To prioritize constraints in relation to potential impact, it will often be as important to carry out a needs assessment for different user groups as it has been to identify biological production constraints in order to plan research.

Consider, for example, the choice between labor-saving or labor-using technology in terms of its differential impact on women. Information on women's time allocation and participation in different cultivation activities is essential to determine potential impact. The data on women's contribution to rice cultivation activities in Asia suggests that the mechanization of threshing will depress demand for women's labor. When labor-saving technology is introduced to rice threshing, it benefits women in farm households who can re-allocate time from harvesting into more profitable work. When labor-saving technology displaces landless female laborers who depend on harvesting for income in cash and kind, they tend to work longer hours for lower wage rates. This may have adverse effects on household welfare related to increased workloads and declining income of women discussed earlier.

Research plans that propose to take into account differential impact on women need information of this type
on the division of labor to assess the implications of tackling alternative constraints before technology designers get to work on solving problems. In Latin America, this information is difficult to come by and extremely heterogeneous or situation-specific, as discussed below.

Sex Roles and the Participation of Women in Latin American Agriculture

Sex roles in Latin American agriculture must be interpreted in terms of cultural ideals about appropriate behavior (popularly described as "machismo") and objective performance of role obligations, which are not necessarily congruent Cultural ideals cause male and female self-perceptions of the work they do in agriculture to designate men's work as field work and women's work as "house work." However, detailed studies of the tasks women and men actually take part in shows that the actual division of labor (either domestic or agricultural) is not necessarily demarcated into exclusive sex-specific tasks. This flexibility in the performance of sex roles in Latin American peasant agriculture is related to cultural factors (the strength of Hispanic versus Indian traditions); social class (whether income comes primarily from land or wages); and the degree of market integration of the peasant economy. There is, therefore, great heterogeneity in the work roles performed by women in Latin American agriculture. This section of the paper discusses the evidence of women's participation in the agricultural labor force in Latin America with the objective of illustrating some of this diversity and its implications for agricultural technology research and development.

The aggregate picture of women's participation rates in the agricultural labor force in Latin America given by census estimates supports the use of the term "male farming system," interpreted as agriculture in which men do most of work. As the figures summarized by region in Table 4 show, women appear to form a small proportion of the total agricultural labor force in Latin America although there are substantial regional variations. Only a small proportion of women defined as economically active are employed in agriculture. However, these estimates must be interpreted with extreme caution. Numerous microstudies find much higher participation rates for women when they take into account several conceptual problems in counting agricultural work done by women. Such problems include cultural perceptions of what work women do, which causes women as well as men to report a woman's primary occupation as "housewife" even though more detailed interviewing discloses other agricultural employment. For example, one study in Cajamarca, Peru, found 46% of households reported female employment in agriculture, but detailed interviewing showed women engaged in farm work in 96% of households (Deere, 1982). Other factors that cause under enumeration in Latin America of women's agricultural labor force participation are census definitions of what constitutes economic activity by unpaid female family workers, minimum hours of work required by census definitions, time reference periods of census interviews and the seasonality of female work. Some authors argue that changes in census classifications may account for the apparent drop in the number of women enumerated as economically active in agriculture in the region since the 1950s (Lopez and Leon de Leal, 1977; Dixon, 1982). FAO's 1970 agricultural census counted numbers of persons engaged in agricultural activities on a holding regardless of the time involved or whether paid or unpaid. The results showed higher female shares of the agricultural labor force than found by ILO (1977) and census estimates in 32 countries. For Central and South America, the FAD-estimated proportion of females in the agricultural labor force is 19%, and for the Caribbean, 54%, on average three times as high as rates for Latin America reported elsewhere (Dixon, 1982).

Micro-studies of women's participation in smallholder agriculture in Latin America consistently report involvement of women in planting, fertilization, weeding, irrigation, harvesting, threshing, fodder collection and animal care (see for example Borque and Warren, 1981; a review of micro-studies from the Andean countries in Deere and Leon de Leal, 1982; case studies in Colombia in Leon de Leal, 1980; Rubbo, 1975; Alberti, n.d.). In most cases, the data are not analyzed in such a way as to enable one to identify a clear-cut sexual division of labor, except with respect to land preparation with the plough (or tractor), which appears to be almost exclusively a male activity. To illustrate this diversity of finding, Table 5 reports data from one of the few studies which quantifies and desegregates participation rates by agricultural field task. The percentage of women who participate in any given task, such as planting in Table 2, varies substantially from one community case study to another.

One of the major shortcomings of micro-studies of the sexual division of labor in Latin American agriculture, from the point of view of agricultural research, is their neglect of crop-specific variations in the tasks done by men and women. If participation rates in agriculture were desegregated by sex, field operation and crop, it might then be possible to interpret some of the diversity of findings. Moreover, several studies show that important differences in participation rates occur by farm size strata, so that this variable must also be controlled for when interpreting participation rates by sex. For example, Table 6 compares the percent of total labor days by field operation contributed by women from two farm size strata in two different crops, maize and tobacco. These data come from another study of one of the Colombian communities, El Espinal, for which aggregate female participation rates were shown in Table 5. It can be seen that aggregate participation rates in Table 5 do not reflect consistently the picture shown in Table 6 for different crops. There are substantial differences in the percentage of labor days contributed by women to maize cultivation in the two farm size strata. Women on small farms, mostly family laborers, do a higher proportion of the work in maize compared with medium-sized farms where women are hired for maize operations. In tobacco cultivation the pattern is quite different. Women still do more work in tobacco on small farms, but most of the female labor is hired, and women participate in all field operations. In contrast, all female labor for tobacco is family labor on medium farms, and female input is specific to certain field tasks. These data illustrate the heterogeneity of women's involvement in agriculture in Latin America and the difficulty in extrapolating from the available data to derive implications for the design of commodity-specific agricultural technology.

Another consideration is that the sexual division of labor in Latin American smallholder farming systems appears to be such that men and women participate in the same field operation, such as planting potatoes, but planting techniques are broken down into components that may be sex-specific. For example, men make the holes or furrows, and women place the seed. Borque and Warren (1981) argue that there are key tasks within broad categories of work that are reserved to men and thus function as a mechanism for excluding women from access to critical resources:

> Women participate in a broad range of agricultural activities, sometimes side by side with men, on other occasions in a fashion that complements men's work. Yet women's status appears to be more clearly shaped by those tasks from which they are excluded. Women plant, irrigate, and harvest; they do not break up hard earth with pointed metal rods, plow fields, open irrigation channels, or tie sacks of the harvest onto burros. Because women are excluded from tasks such as soil aeration and plowing, they cannot directly open up new private land-holdings or extend communal fields. Nor can they begin the agricultural cycle on old fields without assistance. Because women cannot load the harvest on pack animals, they are dependent on men as a link in the chain of events which establishes the value of crops women produce alongside of men.

A similar observation is made in another study that shows that the use of tools or implements draws cultural boundaries on the tasks in which women engage and that this extends to the use of tractors or sprayers for fumigation (Deere and Leon de Leal, 1982). Women tend to participate in all agricultural tasks in primarily subsistence crops but only in non-mechanized tasks in industrialized crops such as irrigated rice, cotton, coffee and sugarcane (Gonzalez, 1980).

The available evidence is that in Latin America, women cannot be ruled out a priori as participants in any of the agricultural field tasks entailed in smallholder production. The extent to which women participate and the sex-specificity of tasks depend on several variables:

1. The role of a given crop in the household subsistence and cash economy.
2. Farm and nonfarm employment opportunities for either sex.
3. The availability of male labor (family or hired) to substitute for the labor of farm women.
4. Cultural perceptions of what are key tasks reserved exclusively to men.

In summary, two major characteristics of the sexual division of labor in Latin American agriculture stand out. Industrialized crop production in the large farm sector involves a division of labor that is quite sex-specific. Women are hired as wage laborers for tasks such as coffee harvesting and cotton picking that have not been mechanized, or they work alongside men as members of migrant labor families doing piece work. Regional differences in the tasks man and women perform depend on the local supply of male and female wage labor and the substitutability of male and female labor in the large farm sector. In smallholder agricultural systems, the division of labor is structured around interdependent sharing of tasks by the sexes when men work on the farm alongside the women. The sex-specificity of tasks appears to be diverse and flexible or responsive to changing labor market relations. When men work off-farm, women family workers have higher rates of participation in the same tasks that are male-dominated on farms that hire in labor. The interdependence of the sexual division of labor on small farms suggests that identifying women as special users of agricultural technology in Latin America is extremely exacting in requirements for detailed data on the sexual division of labor on a case by case basis.

LINKAGES TO ENSURE FEEDBACK FROM USERS TO TECHNOLOGY DESIGNERS

In an ideal world, policy makers and research managers would be able to set priorities and develop strategy for agricultural research by factoring different user circumstances and considerations of the division of responsibility and welfare among household members into ex-ante evaluation of impact. In the real world, predicting the likely impact of a possible technology on any particular user group is extremely difficult. As the preceding discussion illustrates, the data required to carry out ex-ante evaluation of impact for many diverse and complex user circumstances are extensive. Policy research to assess the implications of gender for impact on productivity vs. other goals such as the stability and quality of food supply unquestionably has a vital role to play in helping to identify broad issues that deserve consideration in technology design and choice. However, the diversity of rural women's circumstances and of potential impacts that can arise from technological change means that gender implications ultimately have to be accommodated in technology design through greater involvement of women as users in problem definition for research and in technology evaluation. The issue is fundamentally one of how to institutionalize the participation of women users in the research process to inform research strategy and orient technology design.

Conventionally this is seen as a function of farming systems research (FSR) that combines "downstream" location-specific research to generate short-run technological improvements for specific groups of users with "upstream" research on major widespread constraints. In this way, FSR aims to provide an integrated approach in which area-specific research is the basis for defining longer-term research priorities.

However, the area in which FSR has been weakest is in applying information on user circumstances to provide feedback that orients research strategy. To a large degree, this reflects the "downstream" orientation of FSR programs that are viewed by many FSR practitioners and by research managers as the final interface between producing finished technologies (the problem-solution stage of research) and agricultural extension. As a result, FSR feedback is often limited to validating finished or developed technology once fundamental parameters of the research strategy that produced the technology in the first place have long ago been set.

In order to accommodate more refined or segmented user groups, the FSR perspective needs to be more "holistic" to account for the gender and intrahousehold differentials in technology impact discussed earlier. This can imply greater investment in FSR resources, especially in the analytic capacity of FSR researchers, to identify the multiplicity of potential user groups for whom potential innovations have to be screened.

Successful innovative private-sector organizations in the developed countries carry out user-oriented research in three ways that are relevant to this discussion;

1) by ensuring that management responsible for basic strategy decisions understands user needs, by being active recipients of feedback coming in from intensive direct contact between technology designers and users in the research process;
2) by involving potential users in early experimentation that exposes clients tangibly to prototype technologies, allowing the user "to see it, use it, reshape it," emphasizing speed and practical risk-taking; and
3) by organizing technology designers in relatively small groups for problem-oriented projects or thrusts, which may be of limited durations to achieve this prototype testing and development.

These features of successful technical innovation raise several issues for FSR methodology and organization:

- what institutional linkages can be created to inform research managers and technology designers in commodity programs rapidly about relevant criteria for assessing potential impact on women and of technological options or prototypes?
- how can potential users such as women be involved early in the technology design process so that the acceptability of prototypes (rather than developed technologies) can be assessed?

In response to these concerns, there exists a groundswell of interest in the development of participatory research methods with the objectives of actively involving users in problem definition and prioritization to generate research agenda and enabling users to have direct hands-on involvement in technology design. For example, it is widely recognized (albeit mostly in anecdotal sources) that women are important "barefoot" breeders, selecting and conserving desired genetic materials. To the extent that crop breeding represents a major area in which potential gains are expected from international research for poor and disadvantaged users, breeding programs need to address the question of how users should be given a role in formulating breeding objectives.

Such questions immediately lead to consideration of what types of research organization may be required to accommodate user-participation in technology design. On the one hand, it can be argued that decentralization is at the heart of the issue of achieving intensive interaction with users towards effective adaptive research that takes into account multiple users and their welfare. On the other hand, existing resources and manpower are scarce and must be concentrated effectively to achieve any impact on priority problems or regions.

This issue can be usefully analyzed in relation to three interrelated stages of technology transfer illustrated in Table 7:

1. direct transfer of materials (seeds, machinery, chemicals);
2. transfer of designs (methods, formulas, techniques), which represent ways of developing "materials";
3. transfer of capacity (human skills and institutional models) or ways of developing "designs."

The issue of whether user-oriented research is likely to detract from the ability of agricultural research programs to focus a relatively small but critical mass of talent on specific problems may have to be addressed in

terms of the extent to which their efforts are concentrated on the transfer of "capacity," that is on providing organizational models, methods and skills for conducting user-oriented research.

If public-sector resources for agricultural research are not adequate to address the adaptive research needs of multiple user groups such as women, how can the private sector (i.e. users) be catalyzed into taking greater responsibility for adaptive research? This question suggests the need to develop methodologies that will help users identify problems and constraints and test and evaluate technology prototypes in their own systems. Participatory methods for delivering feedback to technology designers generated by women as technology users are critical to the generation of technology that will benefit women.

SUMMARY

The nature of women's roles in agricultures as producers of staple foods, as managers of food systems and as income-earners who contribute directly to food availability means that they can be an important client group for the agricultural research process given the broad goal of improving food availability for the disadvantaged. The characteristics of production by women and other activities of women that contribute to food availability and welfare need to be broadly identified. Accommodating these into technology design requires in the first place institutionalizing in the earliest stages of the research process a commitment to making a contribution to women's activities. This commitment has to occur at the advisory level in the research process when policy and priorities for research are set

The available evidence for Latin America indicates that gender differences influence technology adoption, food production and welfare of the rural poor in Latin America, but the research base is so weak that the relative importance of gender in research priorities must be treated as an empirical question. Moreover, the type of data on the sexual division of labor in agriculture required for technology design has not been collected. In order to accomplish these tasks, three types of needed research must be addressed:

1. Studies of the division of labor in farm and non-farm activities to document the division of labor by sex and between hired and family labor on a crop-specific basis.
2. Studies of intra-household resource allocation to permit inferences about the importance of sex-related incentive structures for the design of new technology. Such studies need to give careful attention to the issue of how sex-specific spheres of influence can be defined empirically and to the outcomes that will be measured (nutritional, productivity, income, expenditure and technical choice).
3. Appropriate categories in census or survey research to estimate the distribution and relative importance of different groups of rural women likely to be affected by technical change in agriculture.

This information is needed to assess the relative importance of gender as a criterion for identifying special user groups and their needs.

As discussed earlier, when adaptive research or FSR concerns the details of problem identification and technology design for specific user groups, it becomes extremely difficult to predict ex-ante what the user implications are of a specific technology for a particular group in their social context at a specific moment in time. It is a cliché in management theory that user-oriented technology development requires intensive contact with users. While FSR is at the cutting-edge of user-contact in the global agricultural system, it has been noticeably deficient for example, in accommodating gender differences. The question is, what should be done to modify FSR to accommodate more complex and refined definitions of potential user groups such as women? What can be done to provide rapid feedback from many diverse users to technology designers without imposing excessive demands on the resources and managerial capacities of public-sector agricultural research systems? Is investment in multiplying decentralized FSR programs a feasible solution to the increased need for adaptive research implied by recognizing diverse user groups? Will it become increasingly imperative to create capacity among user populations to participate in the research process? Can FSR respond to this challenge by adopting participatory methods and developing institutional models that enable farmers, and in particular women, to take a more active responsibility for location-specific adaptive research?

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Table 1. Examples of technology design parameters that have differential gender-related impact

Rural woman's work roles and time allocation	Potential impacts of technical change on women	Implications for technology design: examples
Women's domestic work - water carrying - fuel gathering - post-harvest processing - food preparation - child care	- Women's workloads and time allocation among different activities - Women's food preparation preference	1. Commodity choice - subsistence vs cash crop - food vs fuel?
Women's subsistence production - garden plot - subsistence crops - small animal care activities - forage collection	- Women's child care & child nutrition activities - Women's ability to obtain stable, year round food, fuel and forage supplies	2. Cropping system choice - varietal-crop mix? 3. Crop-livestock interface - food vs forage?
Women's marketing activities		
Women's un-paid labor on family farms	- Women's control over farm management (production inputs)	4. Varietal choice - yield vs. biomass?
Women's agricultural wage labor Women's non-agricultural wage labor	- Women's control over farm output, income and expenditures - Women's access to income dependent of male or family control	5. Management practices - labor-saving vs - labor-demanding?

Table 2. Urban-rural distribution of female population in Latin America by region.

Region and country	Percentage of female population Urban	Rural	Total number rural women
Brazil	69	31	18,508,758
Mexico	66	34	11,258,516
Tropical South America	63	37	12,673,582
Central America	43	57	6,267,103
Caribbean	56	44	3,294,812
Temperate South America	84	16	1,151,862
Total Latin America	65	35	53,181,633

Source: United Nations, 1982.

Table 3. Distribution of women economically active in agriculture by occupational category in Latin America.

Region and country	Percent of women in agriculture Self-employed	Employers and laborer	Family
Brazil	35.7	17.1	47.2
Mexico	35.4	44.0	20.1
Tropical South America	53.7	18.9	23.8
Central America	14.1	64.0	19.1
Caribbean	18.0	11.4	64.5
Temperate South America	30.2	43.0	24.9
Total Latin America	32.5	20.9	44.5

Source: ILO, 1977.

Table 4. Census estimates of women's participation rates in agriculture for major Latin American countries and regions.

Region or country	Women as percentage of total agricultural labor force	Number of women employed in agriculture	Percent of all employed women active in agriculture
Brazil	9.6	1,257,659	20.3
Mexico	5.2	266,654	10.8
Tropical South America	6.0	342,125	8.9
Central America	2.6	69,264	7.3
Caribbean[1]	32.4	640,291	45.1
Temperate South America	5.6	105,410	3.6

[1]Excludes Cuba
Source: ILO, 1977

Table 5. Percentage of women participating in agricultural field tasks in three smallholding communities, Latin America.

Field operation	Community case study: Garcia Rovira, Colombia	El Espinal, Colombia	Cajamarca, Peru
	%		
Field Preparation	10	14	24
Seeding preparation	29	21	NA
Planting	30	16	48
Transplanting	7	32	NA
Weeding	4	31	47
Cultivating	4	20	24
Harvesting	46	52	62
Threshing	NA	NA	66
Processing	51	36	NA

Source: Adapted from Deere and Leon de Leal, 1982.

Table 6. Participation of women from two farm size strata in field tasks in maize and tobacco cultivation, El Espinal, Colombia

		Women': s labor as percent of each operation					Percent of female labor	
Crop	Farm size[1]	Land prep	Planting	Cultivation	Harvesting	All Tasks	Hired	Family
Maize	small	12	23	20	23	21	12	88
	medium	0	8	7	6	6	100	0
Tobacco	small	33	50	30	49	38	79	21
	medium	0	0	34	15	21	0	100

[1] Small farms: 0.01-3.00 ha; medium: 3.01-10.00 ha
Source: Adapted from Motta de Correa (1980), Table 8.

Table 7. Types of technology transfer.

Transfer of material	Transfer of human capital design	Transfer of & Institutional development
Examples	Examples	Examples
Crop varieties	Farming-systems methods	Organizational models
Livestock breeds	Laboratory methods	
Chemical inputs	Post-harvested processes	Research management capabilities
Machinery, tools and	Breeding techniques	Professional standards and values
Forage varieties	Seed production techniques	
	Policy research	Models for information management (net work)
Training	Training methods	Research skills

Social Class	Types of Farm Enterprises	Farm Labor Relations	Types of Women
Traditional landed elite	Haciendas (precapitalist estates)	Employ permanent Minifundista labor force	Absentee or wives of farm managers
Capitalist landed elite	Estates and plantations	Employ mainly seasonal wage laborers	Absentee or wives of farm managers
Rural Middle class	Capital-intensive farms	Employ permanent and seasonal wage laborers	Absentee or part-time residents or wives of farm managers
Well-to-do smallholders	Small commercial farms	Use exchange labor, wage labor, family labor	Farm "housewives"
Peasants	Mixed commercial farms	Family labor, hire out some labor for wages	Farm domestic and field workers
Rural proletariat	Minifundias (near landless)	Hire out most labor for wages and farm in slack periods	Women minifundistas
	Landless	Hire out all labor	Women wage laboreres: "female underclass"

Fig. 1. Types of rural womaen in Latin America related to social class and type of farm enterprise.

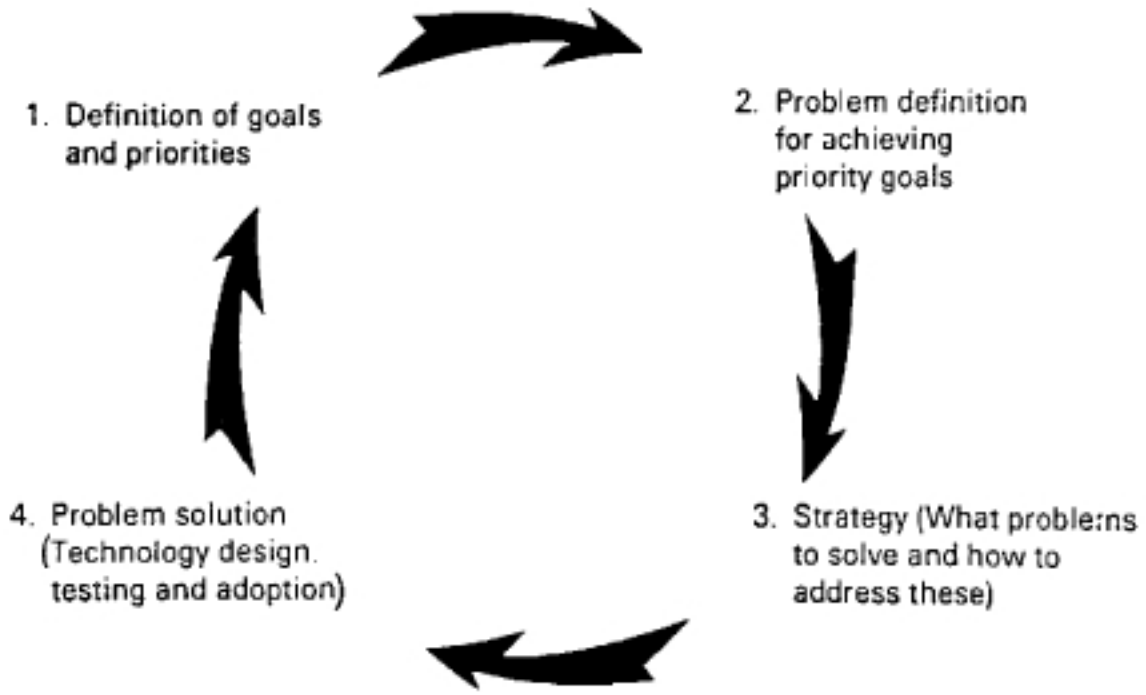

Fig. 2. Stages of the research process.

Structural Changes in the Rural Sector, Latin America →	Rural Women's Work Roles and Time Allocation →	Intervening Variables →	Outcomes for Rural Poor
Declining size and stagnant productivity on small farms.	Women's domestic work (includes post harvest processing).	Women's food preparation preferences.	Adoption of agricultural technology.
Mechanization of capitalist agriculture.	Women's subsistence production (crop and small animals)".	Women's control over farm output, income, and expenditures.	Household food avail ability; home produced versus purchased food.
“Proletarianization" of peasant class	Women's marketing activities	Women's control over farm management (production inputs).	Household savings and expenditure patterns.
Outmigration.	Women's unpaid labor on family farms.	Women's childcare and fertility control practices.	Child nutrition, health, mortality, and education.
Female-headed farms	Women's employment as agricultural wage laborers.		
	Women's nonagricultural wage labor. .		

Fig. 3. Schematic diagram of causal relationships between gender-related factors, food production and welfare of the rural poor.

FSR/E *AL PARTIR:*
SHARING RISK WITH HIGHLAND COMMUNITY FARMERS IN THE MANTARO VALLEY, PERU

Constantine Gregory[1]

INTRODUCTION

Most FSR/E and government extension projects subsidize farmers in the initial stages of technology experimentation, validation and transfer. In participatory on-farm trials, the project (researcher/extensionists) must often provide at least part of the inputs—fertilizers, for example—because farmers are seldom willing to run all the risks of research on their own. Credit programs used to facilitate the introduction of technological packages, with interest rates well below the commercial rates, are in effect subsidies to farmers.

The apparent necessary evil of subsidies, however, is not the only choice open for FSR/E. Grupo Yanapai, working in the Central Sierra of Peru, has found that the *al partir* system, an egalitarian form of sharecropping widespread in the Andes, is one of the most effective financial arrangements for FSR/E. The shared risk and common interest in production inherent in the *al partir* arrangement have narrowed the distance and improved the communication between farmers and researchers. Farmers seem to take more pride and have more interest in research when they are "partners" rather than the recipients of gifts.

Grupo Yanapai, a non-profit organization that together with the Small Ruminant Collaborative Research Support Program (SR-CRSP), and in collaboration with the Peruvian National Institute for Agricultural and Agro-industrial Research (INIAA), works through mutual agreement with small-scale farming communities and women's agricultural production communities of the highland communities of the Central Sierra of Peru. The work is directed toward the validation of recovered as well as introduced technologies to improve the levels of productivity. The methodology approach of participation-action-research pursues to reinforce the scientific knowledge, the autonomy of decision-making and the historical identity of the participating groups. The members of these groups participate in the stages of problem identification, planning, execution and evaluation of the actions to be taken.

The experience described herein is part of a five-year experience in three small farm highland communities (3,500 - 4,000 m above sea level) of the Mantaro Valley, Peru. The zone is at a latitude of 11:57 S and a longitude of 75:25 W; its maximum temperature is 26 C with a minimum of -6 C. The soil varies from sandy to clayey. The water retention capacity of the soil increases with altitude. The vegetation is primarily made up of natural pastures, and bushes are more common than trees. The rainy season lasts from September through March; the planting is done between October and December, depending on when the rainfall begins. Between one- and two-thirds of the cropping land remains fallow at any given time. The fallowing periods last from three to seven years, depending on the quality of the soil.

The community is a socio-political entity made up of the registered families that reside in a geographic zone. The maximum political and administrative local authority is the general assembly, constituted by all men, widows and single women head of households. The *comuneros* are expected to assume communal responsibilities according to their possibilities and to participate in communal work parties *(faenas)* when necessary. The families that live in the community have the right to share communal benefits according to how much work they put in. The general assembly decides what is to be done about all natural resources (water, forestry, pasture lands) and infrastructure (roads, schools, health units); they also decide on contracts made with federal institutions and external private entities.

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[1] Constantine Gregory was economics research assistant of the Small Ruminants CRSP (Winrock International). He and Gustavo Rojas, a Veterinarian of the SR-CRSP, were assassinated on June 13, 1988, while working in the Aramachay area. At that time, C. Gregory was working on this article. Norma Canales (Winrock International) and Maria Fernandez (University of Missouri), also with the SR-CRSP/ Yanapai, wrote the Spanish version. Dolores Fernandez-Gregory and Domingo Martinez edited and translated it into English in the hopes that it reflects the analysis originally intended. The investigation that served as basis for the work was done with the support of Winrock International and the University of Missouri, Columbia, with funds provided mainly by AID through its grant AID/DSAN/XII/ G-0049, SR-CRSP. Constantine Gregory has been honored posthumously with the U.S. State Department's End World Hunger award. Inquiries should be addressed to: Maria Fernandez, Grupo Yanapai, Casilla 264 Huancayo, Peru or to: Domingo Martinez, 318 Mumford Hall, University of Missouri, Columbia, MO., 65203, U.S.A.

The family production unit is made up of an average of six members and functions as a small business in which the decisions are made by adult members of the family (husbands, wives and adult children). The daily production decisions are made by the adult in charge of the unit: generally, animal husbandry decisions are made by the women and cropping decisions by the men. Labor is shared among all family members, with specific tasks assigned according to gender and age. During the time of high labor demand (planting, harvesting, threshing, shearing and branding), additional labor is supplied by relatives, friends or *compadres* in a system of reciprocal exchange called *Ullay. Ullay* is a verbal form of mutual agreement by which a number of families (around six) help each other. Use of hired labor is less frequent.

The production system is a mixture of animal husbandry and cropping, and in some cases cottage industry, commerce and waged labor are also present. The animal species of greater value are sheep, followed by cattle, donkeys and swine, most of which are *criollo* (breeds adapted since the Spanish conquest). The animals feed on natural pastures and crop residues. Cattle and donkeys, used as draft and cargo animals, respectively, receive supplementary feed (grains and forage) during the work periods. Sheep, which are sporadically sold alive, provide manure and wool, besides being a form of savings. Guinea pigs and chickens are raised mainly for family consumption.

Dryland fanning by a family consists of an average of 12 crops cultivated in about 20 plots (between 0.1 and 0.3 ha), many of which are located on steep terrain. The main crops are tubers (potato, *mashua, oca, olluco),* grains (barley, wheat, oats, *guinua),* legumes (broad-beans, peas, *tarhui),* and in some cases maize. Intercropping among species and varieties is quite common. The crops are valued for their multiple use in animal and human nutrition. A considerable proportion of barley and potatoes is marketed outside the community.

POTATO SEED PRODUCTION PLOTS

The planting of native and commercially improved varieties of potatoes is an important activity to the small farmer. The production of native varieties, which have a higher percentage of dry matter per unit of weight, is mainly destined to self-consumption, while the other "improved" varieties, of greater yield per hectare, are destined to the market.

To produce potatoes, the highland small fanner uses very few external inputs and his own seed selected from the last harvest. To renovate their seed, every three to five years farmers exchange small quantities of seed with acquaintances who have a reputation of being good producers in their zone. They do not use commercial seed due to its high cost, except when they receive a small amount of a new variety that they would like to try for yield and quality.

From the beginning of the program's work in Aramachay in 1983, the farmers asked for support in solving the problem of potato seed degeneration. That same year, a joint effort between the INIAA (then INIPA) and the Swiss Technical Cooperation initiated a program based in the Central Sierra, with the objective of producing virus-free potato seed *(semilla basica,* or basic seed) and distributing it among small- and medium-scale farmers.

For the 1987-88 planting season, the program began selling basic seed in quantities of 300 kg to be used in community seed production. The planting of basic seed in communal seed plots has the objective of providing the community members with virus-free seed at a minimum cost. The use of seed produced from basic seed allows the producer to expand his/her renovation period from three to seven years and to increase production 20%. To support the community members in finding a solution to the seed degeneration problem, Grupo Yanapai and the SR-CRSP have proposed the installation of seed plots in three communities of the Aramachay area. Although the communities and women's agricultural production committees were interested, they did not have the capital needed to buy the seed and all other inputs needed to install the seed plots. The project team began talks to find a way in which economic support acceptable to the communities could be given and to guarantee at the same time that the seed plots be self-sufficient.

The first proposal discussed with the farmers was a cash loan. After studying the matter with the team members and later with the farmers, it was determined that the possibility of returning the loan was uncertain, given the high rates of inflation existent in Peru and the high risks that the introduction of a new technology poses. It was then that the farmers themselves proposed the *al partir/*sharing risk method, which is a form they use to have access to farming land when they have insufficient capital. The *al partir* arrangement is used by families that have different resources. Each party provides certain inputs needed to plant, and the harvest is divided according to the value of the original inputs.

This arrangement meant that the support provided by Grupo Yanapai would be returned in kind, which posed some difficulties for storage and marketing. After a long debate over the matter, it was decided that, although this arrangement was somewhat inconvenient for Yanapai, the *al partir* arrangement would guarantee a fuller participation of the farmers not only because it proved to be a worthwhile technology but also because the group was willing to take the same risks as the farmers.

As a result of several conversations with the Women's Agricultural Committees of San Antonio de Quicha and Aramachay and with the community of Miraflores, it was settled that the harvest would be divided in equal parts, each party agreeing to provide the following resources:

Grupo Yanapai	**Committee/Community**
Seed	Land
Fertilizers	Manure
Pesticides/Insecticides	Labor
Technical Aid	Participation in training activities
Other Expenses (coca leaves, alcohol for *faenas)*	

To implement the seed plots, the members of the committees asked one of their members to lend a plot of 1250 m^2; in the case of Miraflores, the community designated an area of 3125 m^2. All agricultural labor was carried out in the form of *faenas,* or communal work parties. In the case of the committees, all the members participated (12 and 18 respectively): in the case of the community, one member of each family (50) participated. Those women who had contributed with lending their land were awarded the production of the middle furrow (the longest one). Each committee planted 300 kg and the community 600 kg of basic seed of the Peruvian Yungay variety.

The agricultural tasks carried out in *faena* included:

PICADO: weeding with pick (20 cm plants)
APORQUE: turning the soil one month after *picado*
FUMIGATION: at the times of *picado* and *aporque*
CORTE DE MATAS: cutting the green parts of the plants, six weeks before harvest

The field team agronomist took advantage of *the faenas* to carry out workshops on the characteristics of the virus-free basic potato seed, the use of insecticides and the methods of evaluating the incidence of plagues and diseases in potatoes. These workshops were given in a conversational form, exchanging information and experiences between the farmers and the agronomist. Two months before harvest time, the team economist made an analysis of the production costs in meetings with the two committees and the community.

At planting time, the *faena* authority divided the participants in groups, as follows: *surcadores* (in charge of making the furrows), *quaneros* (who were to apply manure), *fertilizadores* (in charge of fertilizer), *sembradores* (who would put the seed) and *tapadores* (in charge of covering the seed with soil). The synchronization of the work was such that the planting of the 300 kg of seed was completed in less than an hour. The husbands of the members of the committees would help with the *aporque,* because of that task's requirements of greater physical effort.

During the growing season, the members of the community were in charge of caring for the plot on a rotating basis. Yanapai provided the coca leaves (for chewing) and the liquor to the person in charge of the night vigil (providing coca and liquor is traditional in *faenas,* especially when that involves nocturnal work). At the time of the cutting of the leaves, each partner of the *al partir* arrangement (i.e. Yanapai and the committee/ community) sampled the tubers, estimating the yields by their own methods.

Each group determined the harvesting date, being careful that it did not coincide with the "green" or new moon to avoid the rotting of the seed to be stored. The harvest was done with a oxen team paid in equal parts by Yanapai and the committee/community members. The harvesters of Yanapai were in equal number to those of the committees; the members of the team and the ones hired received half a sack of potatoes as payment for their work (a sack contains approximately 70 kg). During the harvest, alternate furrows were allocated to each partner of the *al partir* arrangement, as is traditionally done.

The harvest of the committees was distributed among their members at three sacks (210 kg) each. Some of the Yanapai harvest was stored, and the rest was sold. The community harvest stored part of the seed, enough for the following year's production, and the rest was sold to finance works that needed to be done in the community. Yanapai's portion was sold to a community member, who sold later part of it and stored the rest with the intention to sell it to farmers at the beginning of the next season. The community has expressed a desire to get other varieties of basic seed to be planted in 1988-89.

COSTS AND BENEFITS OF PRODUCTION

The economic evaluation of the plots of basic seed consists of estimating the production costs for each of the partners in the *al partir* arrangement and also the marginal benefits that come about from the trials in the communal plots. The cost/benefit ratio could be evaluated from two different standpoints: first from the distribution of costs incurred by those participating in the arrangement and second by the comparative benefits vis-a-vis the more usual subsidized loans or inputs from external institutions.

The production costs under the *al partir* arrangement (Table 1) show that the inputs provided by the group/ community were those that are readily available to them, namely land, labor and manure, which represent 47% of the total production cost. Seed, industrial fertilizers and pesticides and the additional labor needed for the harvest, i.e. the inputs purchased with money by Yanapai, represent the other 53%. This shows a difference of 6%, which would be the subsidy given to the participating committee/community.

Instead of using percentages or money to make the economic evaluation, it is preferable to use potatoes, whose value is readily understandable by the farmers, especially taking into account the high inflation rates existing today in Peru. The equivalent value of 55 sacks of first quality (or seed) potatoes is required to plant an area of 1250 m^2. In the *al partir* arrangement, with costs distributed as in Table 1, the committee/community provided the value equivalent of 25.8 sacks, and Yanapai the value of 29.7 sacks. Table 2 shows the cost distribution, as it was presented to the farmers.

A comparison between the *al partir* arrangement and the loan model is shown in Table 3. It can be observed that, to cover the expenses, the community/committee would have to pay with the value of 97.9 sacks of first quality or seed potatoes, which represent 42.4 more sacks than in the *al partir* arrangement. As only 99 sacks of such potatoes were harvested, this means that the committee/community would have ended up with only third- and fourth-quality potatoes and no seed for the following year's planting season. The data assume a loan to buy the inputs otherwise provided by Yanapai in the *al partir* arrangement.

BENEFITS OF THE *AL PARTIR* METHOD

The results of the *al partir* arrangement indicate that technological validation in small farm communities is more effective and economically efficient when the risks are shared equally among the participating farmers' groups and the institution that proposes the validation.

Five advantages can be identified in the *al partir* arrangement. The first is the assurance that the validation will be completed within the parameters of control necessary to insure an optimal production. The second is that the product or outcome of the technology will stay in the hands of the producers, guaranteeing that, if the trial has positive results, the farmers will reproduce the process by themselves, either individually or using their own organizational forms, such as the women's committees and the communities. The third is that a larger number of community/committee members get to know the technology first hand. The fourth advantage is that the project and/or the researchers learn about the limitations and the possibilities of the technology as a result of their team involvement with small farmers, who often have different opinions and experiences. Finally, the fifth is that the farmers take more responsibility and put more effort into the process of learning and doing research as partners and not mere recipients of gifts.

CONCLUSION

The planting of virus-free potato basic seed in the *al partir* arrangement has shown us that the egalitarian participation of the small-scale farmer in taking the risk of a productive activity facilitates the exchange of knowledge and experience required to validate and transfer appropriate technologies. In the producer's side, it assures the existence of the necessary experience and conditions to evaluate the technology realistically; on the side of the researcher, it provides the information necessary to evaluate and make the necessary adjustments for the introduction of adequate technologies under diverse situations.

This experience has shown that it is possible to carry out participatory and collaborative research making use of traditional institutions. The *al partir* share-cropping arrangement is commonly used by Andean farmers, and it now seems the natural way to carry out on-farm trials. With the appropriate modification, this method can be used to carry out research on other crops and livestock.

Table 1. Distribution of production costs (percentage).

Cost	Community/Committee	Yanapai
Land	4.0	-
Land preparation	2.0	-
Manure	2.5	-
Labor and Oxen	31.0	15.0
Other expenses	7.5	18.0
Seed	-	13.0
Fertilizer	-	3.0
Pesticides	-	4.0
Percentage assumed	47.0	53.0

Table 2. Distribution of production costs (in sacks of first-class potatoes).

Costs	Community/Committee	Yanapai
Land	2.0	-
Land preparation	0.8	-
Manure	1.4	-
Labor/oxen team	17.3	8.2
Other expenses	4.3	10.2
Seed	-	7.3
Fertilizers	-	1.7
Pesticides	-	2.3
Total (sacks)	25.8	29.7

Table 3. Comparison of the *Al Partir* and loan methods (total value in sacks of seed potatoes).

Costs	*Al Partir*	Loan
Community /committee		
Land	2.0	2.0
Land preparation	0.8	0.8
Manure	1.4	1.4
Shared expenditures		
Labor/oxen team	25.4	47.2
Other expenses	14.5	26.0
Yanapai		
Seed	7.3	13.2
Fertilizer	1.8	3.1
Pesticides	2.3	4.2
Total	55.5	97.9

FARMER-TO-FARMER EXTENSION IN MICHOACAN, MEXICO: IMPLICATIONS FOR ADOPTION, PRODUCTIVITY AND INCOME ON SMALL FARMS

Robin Ruth Marsh[1]

INTRODUCTION

From the mid-1960s through the 1970s, stagnation in total maize and bean production in Mexico and an increasing dependence on basic grain imports provoked considerable scholarly and political debate about the "marginalization" of the Mexican peasant producer with major negative consequences for food security, income distribution, rural-to-urban migration and unemployment (Hewitt de Alcantara, 1978; Esteva, 1980; Yates, 1981; Turrent-Fernandez, 1981; Barkin and Suarez, 1985; Austin and Esteva, 1987; Grindle, 1988). Interest in this debate has lessened since 1982, with attention focused on the overall economic "crisis" affecting all classes in Mexico, and perhaps most acutely the urban lower and middle classes (Warman, 1988).

The impact of the "crisis" on the peasant sector and food production is not well documented or understood. Empirical studies, such as the one reported in this paper, are just beginning to emerge. In fact this "impact" is in constant flux as Mexico makes halting progress toward economic recovery while remaining deeply in debt and unable to generate sufficient growth and employment to meet the basic needs of its burgeoning labor supply.

The post-crisis transitional period in Mexico (including major changes in the political structure as witnessed during the recent presidential election) warrants a reexamination of development strategy options and, within this framework, a reopening of the debate on the role and future of the peasant sector.

Maize and beans continue to be the basic nutritional staples for most Mexicans. Although the substantial decline in average real income since 1982 has resulted in a decline in effective per-capita demand for food, even for low-cost basic grains, total food demand continues to outstrip domestic supply (the estimated deficit for 1988 is over 3 million tons of maize) (Austin and Esteva, 1987). Attempts by the de la Madrid government to promote basic grain production and "integrated rural development" (PRONAL, PRONADRI) have met with little success among small producers.

The major devaluations of the early 1980s combined with the fall in oil prices and ensuing shortfall in foreign exchange make it increasingly costly to supplement domestic supply with imports. Furthermore, the heavy subsidization of maize "tortilla," in place since the mid-1970s, is being gradually phased out in accordance with fiscal austerity and pressure from international creditors. Market forces will dictate dangerously high inflation in tortilla prices for the urban poor unless domestic production can be boosted to all-time high levels. All in all, the need to give priority to food production in Mexico is more clear in the post-crisis era than ever before.

FOCUSING THE SMALL FARM PRODUCTION DEBATE

Undoubtedly, the accomplishments and lessons of the Puebla project in Mexico, together with the published work of one of its founding fathers, Dr. Turrent-Fernandez, have contributed enormously to current theories on the adoption of agricultural innovations, risk aversion and small farm productivity. In 1982, Turrent-Fernandez predicted that the widespread, appropriate adoption of existing agricultural technologies, thus far unknown on most rainfed farms, would double average maize and bean yields from 1.34 to 2.42 tons/ha and from 0.44 to 0.66 tons/ha, respectively (Turrent-Fernandez, 1981). Indeed, Puebla project credit beneficiaries surpassed that prediction, obtaining average yields of 3 tons/ha in 1982 (Diaz-Cisneros, 1984).

Key lessons from the long-term Puebla experience include the following: 1) small-scale farmers will adopt appropriate new practices irrespective of age, education or farm size; 2) heterogeneous agroclimatic conditions require micro-specific recommendations based on on-farm experimentation and validation; 3) poor farmers require institutional support to obtain inputs, reduce risk and ensure a market for their products; and 4) rural development is most effective when farmer organizations play a leading role in the process.

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Furthermore, the Puebla project, together with CIMMYT, contributed to and benefited from the conceptualization of the Farming Systems Research/On-Farm Extension approach to technology generation and diffusion, currently in use worldwide. In turn, the FSR/OFE methodology influenced the "Farmer First-and-Last" paradigm, which argues in favor of full small-farmer participation in all stages of the research/extension process. Finally, Latin America and, especially, Mexico have brought to the debate theories and strategies for rural development that caution against overemphasis on productivity gains to the exclusion of important socio-political achievements.

In sum, the mid-1970s and early 1980s were a fertile period for debating the small farm productivity question. This debate generated an optimism about revitalizing the peasant sector with the guidance and assistance of government programs (Puebla, SAM) that has diminished considerably since the onset of the "crisis."

We have argued that in the post-crisis era the need to increase food production in Mexico is greater than ever. Yet peasant production remains stagnant, and migration out of rainfed agriculture continues unabated. In large part this is a result of macroeconomic policies that contradict the lessons learned during the last decade on the essential conditions for promoting small farm productivity. Deteriorating terms of trade for maize production, price uncertainty, high interest and farm insurance rates, lack of investment in rural infrastructure and agricultural research and extension and high inflation in consumer goods create an unfavorable environment for basic grain production.

Consequently, the survival of peasant production is increasingly a matter of retreating from government intervention and overcoming vulnerability to adverse policies by pursuing diversified economic household strategies. In this pursuit, there is evidence that nongovernmental organizations are playing an important role (de Janvry et al., 1988).

CONSULTORES DEL CAMPO, A.C.

Consultores del Campo, A.C. (CC) is a non-governmental organization promoting rural development in the lake Patzcuaro region of the state of Michoacan, Mexico, since 1977. Over a decade of gradual expansion, CC has reached some 50 rural communities with its varied agricultural programs. The principal target population is small farmers, although in recent years CC programs have reached beyond the head-of-household to include women, youth and landless community members.

Interestingly, this organization began with the impetus of two North American brothers, one of them a California farmer who lived in rural Michoacan for many years, together with a Mexican colleague. Their interest was to provide a technical assistance service to neglected areas by helping farmers to identify the key local obstacles to greater productivity and respond to these with simple, low-cost innovations.

Key to CC's initial success in the region was their identification of a major production problem that could be abated with a new and effective technique. The problem was a damaging rodent, the tuza, that thrives in deep, powdery volcanic soils. After exhaustive trials under varied agroclimatic conditions, the CC founders discovered that a maize kernel/strychnine bait placed at tuza-tunnel intersections was the most effective method of control. Used properly, this poisonous bait will increase maize yields by over 30%/ha on average.

This successful entry opened the way for further work in the region. Gradually, an expanding CC staff developed a unique methodology for providing technical, social and organizational assistance to farm households and rural communities. This methodology combines elements from the three approaches to small farm productivity mentioned in the previous section: Farming Systems Research/On-Farm Extension, the Farmer First-and-Last paradigm and Latin American theories on non-formal education, grassroots development and community self-reliance ("autogestión").

The most outstanding feature of the CC methodology is its practice of "campesinos teaching campesinos." Consultores del Capo extension agents (13 at present) are all local small farmers selected for their leadership qualities and agricultural abilities. Recruiting farm advisors from within local rural communities assures a high level of understanding of local needs and constraints and of trust and credibility among the target population. Furthermore, with adequate training and orientation, "tecnico-campesinos" are likely to be more effective than the equivalent agents recruited by the government from the nation's agricultural colleges.

Consultores "técnicos" receive technical training as well as basic literacy, social and economic education from the CC coordinators and invited experts. Weekly training sessions involve general discussion of the obstacles to improved farm productivity, themes as divergent as how to take proper soil samples, trends in interest rates and farmer resistance to change. Discussion is followed by detailed field reports of on-farm

experiment results and extension experiences. Emphasis is given to the importance of maintaining high work motivation and social commitment.

In return for a salary somewhat above the rural minimum, the "técnicos" are expected to carry out on-farm experiments on their own farms and in target communities year-round, provide individual and group technical assistance to interested farmers in selected communities, attend training sessions, prepare reports, promote new CC programs and participate in frequent internal evaluations. The on-farm research is necessary to test the technical and economic effectiveness of alternative practices under conditions similar to those of targeted farmers. Equally important, these experiments help the "técnicos" to convince themselves before they are sent into the Held to convince others.

Another important component of the CC methodology is the involvement of interested farmers in the process of identifying community needs in designing, implementing and evaluating CC-promoted programs. The basic criterion of success is whether the recommended activities spread among the target population, including the poorest among them.

Farmer participation usually takes the form of discussion in group meetings and interchanges with "técnicos" in the field. In 1984, some 200 farmers participated in a major internal evaluation of the entire CC effort in coordination with the international adult education center, CREFAL. This evaluation resulted in a publication by CREFAL that contains the opinions and quotes of numerous participating farmers (CREFAL, 1985). It has served as a guideline for designing future CC objectives, strategies and programs.

Between 1977 and 1983, now called the project's "first phase," CC concentrated on farmer-to-farmer extension of relatively low-cost farm innovations to combine with and "optimize" traditional farm practices, mainly in maize/bean cultivation. These innovations include pest control (tuza, sou, bean and post-harvest insects, weeds), recommended fertilization formulas, green manure and silage preparation, fruit tree transplanting, grafting and pruning and beekeeping.

Consultores has also recognized the need to provide economic incentives for the adoption of recommended practices. As an alternative to the official credit programs, increasingly unattractive because of high interest and insurance rates, CC promotes the formation of community revolving credit funds *(cajas de alionó).* To combat high inflation in farm inputs, especially fertilizers, CC began a program for purchasing and storing supplies in a small warehouse to distribute in a timely manner to participating farmers at lower rates than local markets. Finally, CC has promoted the cooperative direct sale of farm products, mainly maize, to surrounding communities and towns, benefiting both producers and consumers.

Since 1984, the beginning of the "second stage" of the project, Consultores del Campo has widened its objectives and programs in accordance with an evolving understanding of local rural development needs. Experience in the field and analysis of the unfavorable economic terms for rainfed basic grain agriculture created awareness of the strong limits to raising farm productivity and income from maize/bean production alone. The role of CC would have to change and expand to support the changing survival strategies of target communities.

The new approach encompasses nonformal education and training in technical, social and organizational skills for rural men, women and youth. Specific action areas include agriculture, fruit and vegetable cultivation, processing, animal husbandry, community organization, financial management and productive projects oriented toward peasant women. Each program/project is aimed at contributing to the overall CC objective, which is to promote community "self-reliance" (autogestión).

PRELIMINARY SURVEY RESULTS[2]

Survey Design

The preliminary survey results reported in this section are based on field research carried out in the Patzcuaro region of Mexico in 1985/86. The survey was designed to evaluate agricultural adoption, productivity and economic impacts of the Consultores del Campo project on the target population, using the farm household as the unit of analysis. The CC target area is also covered by the government extension program for rainfed areas and the local agricultural research station (CAESIT), both under the auspices of the Ministry of Agriculture (SARH).

[2] The results presented here reflect a preliminary look at the data and consist of descriptive statistics. Econometric analysis of the data and comparisons with a 1975 baseline survey from the region will follow in the author's Ph.D. dissertation.

The SARH/CAESIT programs and extension methodology are not discussed in this paper, which concentrates on the more innovative program, Consultores del Campo. Therefore, in the following sections of the paper, the SARH sub-group is compacted with the CC sub-group without explaining the actual presence and influence of SARH extension agents in those communities. On average, this influence has been quite limited according to farmer sources. Detailed analysis of SARH/CAESIT programs and methodology is included in the author's dissertation.

Sixteen communities were randomly selected after meeting certain minimum requirements. 1) The community had to be a maize growing region, with most households engaged in agriculture as a principal activity. 2) The average farm size could not fall below 3 ha nor above 10 ha. 3) Water resources had to be limited to rainfall and residual humidity. And 4) most farmers had to understand and speak Spanish. Ten farmers were randomly selected for each community from lists of heads of household recently compiled by SARH extension agents.

Of the communities selected, eight work with the CC organization, and eight are covered by SARH alone. This survey design offers the opportunity to evaluate the impact of CC programs and extension methodology on farm productivity and income, as compared with the "status quo."

Interviews were conducted during visits with selected farmers from January to June of 1986. Individual interviews were followed by group meetings where important issues to the community (and to the study) were discussed informally. These meetings were taped with the permission of the participating farmers.

Information collected from the questionnaires was very extensive to permit a thorough understanding of the survey population. Data exist for the following general areas: demographic, agroclimatic, maize/bean production (by plot), technical assistance and adoption, risk perceptions, sources of income, off-farm employment, expenditures and basic welfare. Production data refer to the 1985 spring-summer season for maize and maize/ bean crops. Labor, technology and cost data were taken for one representative plot per farmer.

Basic Sample Characteristics, CC and SARH Compared

The selected communities are located in a mountainous, temperate region characterized by relatively abundant rainfall during the summer, predominantly volcanic (andosol) and reddish clay (luvisol/acrisol) soils and one long growing season, occasionally followed by a short winter season. Within this basic agrosystem, there are a variety of microclimates with correspondingly different farming systems. The survey data indicate that although there is substantial inter-community variation in such characteristics as soil type, farm size and cropping intensity, this variation is fairly equally spread among the CC and SARH communities.

The same can be said for basic demographic characteristics: farmer age and education level, the number and age distribution of children and the size of the family work force. We are, therefore, working with essentially similar sub-group populations, although intra-subgroup heterogeneity is marked.

Survey Results: Adoption

Surveyed farmers were asked about their production practices and use of purchased inputs in general and in more detail for the 1985 growing season. Frequency levels for some of these practices and inputs are summarized in Table 1 for both the CC and SARH subgroups.

The SARH extension programs include specific recommendations on plant density, chemical fertilizer formulas and the use of soil insecticides and provide informal information of the other listed inputs. Consultores del Campo has its own set of recommendations, specializing in the control of tuzas with poisonous bait and the control of bean insects and pests affecting stored grain (other insect).

Table 1 shows that CC farmers have a "general tendency" to use pesticides more than SARH farmers, by 22%. However, in 1985, significantly more SARH farmers than CC farmers combated bean pests with insecticides, by 61%. The adoption of insecticides to control pests in stored grain is more widespread among CC farmers than among SARH farmers, by 45%.

The greatest difference in sub-group adoption rates concerns the method of tuza control. Although essentially the same number of farmers in each sub-group use some kind of control (50%), most SARH farmers use a stake or rifle, whereas most CC farmers use the recommended poisonous bait. The majority of farmers who choose not to control the tuza by any means are not greatly affected by the tuza problem.

Survey Results: Adoption vs. Productivity

Tables 2 and 3 show cross tabulations for the use of bean insecticide and tuza control, respectively, with corresponding maize and bean yields.

Table 2 shows clearly the strong positive impact of using insecticides to combat bean pests for both sub-groups. That impact is strongest for the CC sub-group, even though average and maximum yields both with and without the use of insecticides are substantially below average SARH bean yields. The higher "no insect" yields for the SARH sub-group would tend to indicate more favorable baseline agroclimatic conditions for those farmers.

The survey findings lead us to the conclusion that the use of insecticides to increase bean yields is very effective in the study area, whether promoted by CC, by SARH or by some other source. The CC program (malathion, 2-3 times per season as needed, backpack spray demonstrations and loans) is relatively more effective than the SARH program (parathion, 1.5-2 kilos/ha, no application demonstrations) for increasing baseline bean yields. However, we saw in Table 1 that the CC adoption rate is only 41% (as compared to 66% in the SARH sub-group). This may be explained by the somewhat less favorable conditions for bean cultivation in some CC communities, e.g. a higher incidence of frost and pests. It would be correspondingly more difficult to persuade those farmers to invest in a crop that has historically yielded very poor results (see Table 6).

The data presented in Table 3 on tuza control are much less convincing. Excluding the "none" category, because we have not sorted out non-adopters with a tuza problem from those without a problem, we will concentrate on comparing the relative effectiveness of the two control methods, stake/rifle versus poisonous bait, for the adopting subset. SARH does not promote either method, while CC actively promotes the use of poisonous bait with group demonstrations, individual technical assistance and the sale and distribution of bait at very low cost.

The most interesting and valid comparison presented in Table 3 is the effectiveness of the stake/rifle method for the SARH sub-group versus the effectiveness of the bait method for the CC sub-group. There are too few SARH bait users and CC stake/rifle users to draw valid conclusions about these subsets.

First, looking at the total figures, the effectiveness of the two methods is similar, both obtaining around 1.5 tons of maize/ha. For the sub-groups, however, the yield results suggest that the bait method used by CC farmers may be slightly superior to the stake/rifle method used by SARH farmers, although other factors may well explain this relatively minor difference (9%). CC bait users do seem to have benefited from the CC extension effort as compared with the few SARH bait users who probably learned about the method secondhand.

Nevertheless, the reduction in losses from tuza damage obtained by surveyed farmers does not substantiate CC claims to an average increase in yield of 1 ton/ha, with proper bait application. Proper application involves substantial organizational effort, i.e. bordering farmers must work together so that tuzas do not pass from controlled to non-controlled fields. Intercommunity conflict and lack of unity often preclude this kind of organization without a major, consistent effort by the interested parties in conjunction with Consultores. The stake/rifle method is also precarious and difficult to implement, depending largely on the skill of the individual farmer and his/her "mata tuzas."

The CC/SARH fertilization programs are not discussed in this paper. It should be noted, however, that the quantity of chemical fertilizer used is similar for both sub-groups, although the formulas vary considerably. The CC sub-group used, on average, 140 kilos of chemical fertilizer/ha, 94 kilos of phosphorous and 46 kilos of nitrogen, a 2.04 ratio. The average SARH sub-group fertilizer use was 120 kilos/ha, 62 kilos of phosphorous and 58 kilos of nitrogen, a 1.07 ratio. This formula difference reflects differences in extension recommendations.

Survey Results: Maize/Bean Productivity

Yields for maize and beans were taken for each field planted in 1985 (considered nationwide to be a good year for maize). Farmers estimated yields in terms of "harvest weight," that is as maize cobs carried in sacks from the field. On average, grain weight equals approximately 80% of the harvest weight. Surveyed farmers were also asked to recall average maize and bean yields for the past three years, 1982-84 (Tables 5 and 6).

The mean, minimum and maximum average yield figures for the CC SARH sub-groups are presented in Table 4. The figures are quite similar for both groups in all years. In 1985, the CC sub-group obtained a 20% higher yield from maize-only plots, and SARH farmers obtained a 4% higher yield on maize/bean plots. Recall figures for 1982-1984 give a superior average for the SARH sub-group because of their excellent reported harvest in 1982.

Bean yield figures show the SARH sub-group as consistently superior to the CC sub-group by a wide margin. The explanation for lower bean yields, discussed earlier in the adoption section, seems to be a combination of lower insecticide use and less favorable micro-climate conditions in certain CC communities, as indicated by the lower mean and maximum yields obtained in all four years. CC extension efforts have succeeded in persuading some previous nonadopters to invest in bean insecticides, having witnessed in demonstrations the dramatic increase in production. Others prefer to accept "Whatever comes." We will see later on that the labor cost factor contributes to this latter decision.

We cannot make a statement on the longitudinal impact of CC programs on farm productivity until the results of the baseline 1975 study, still on computer sheets, have been fully reviewed. It seems clear, however, that the presence of CC programs and "técnicos" in the surveyed communities has not significantly changed average farmer adoption behavior and productivity as compared with farmers faced with "status quo" extension efforts.

Even where extension efforts have been quite successful, in pest control and fertilization, the net impact on maize and bean productivity among surveyed farmers does not meet the claims or the expectations of Consultores del Campo. This is the result, most likely, of comparing data collected from a random sample of farmers with data collected from "tecnico"-supervised demonstrations and from "model" adopting farmers. For the "average" farmer, agroclimatic, organizational and economic factors limit full adoption and the technical and economic returns to recommended practices.

Survey Results: Gross, Net, Net Disposable Farm Income

Tables 7, 8, 9 and 10 present data on farm income from maize and maize/bean crops, average production costs per hectare, net farm income, disposable net farm income and returns to family farm labor. Tables 9 and 10 present differences in income and returns to family labor for the CC and SARH sub-groups.

In aggregate terms (Table 7), median gross income from maize-only production was US$ 604/farm and from maize/bean production, US$ 699/farm. The guaranteed price for maize at harvest time (53 pesos/kilo) was used to calculate the value of production. That price is somewhat higher than the average price received by sample farmers selling at harvest time but is somewhat lower than the price obtained for maize sold later in the year.

Table 8 shows a breakdown of average and median per hectare variable production costs for representative sample maize and maize/bean plots. The variable costs are divided into monetary, in-kind and family labor costs. Monetary costs include expenditures for purchased inputs, tractor rental and transportation. Interest and insurance payments are not included. In-kind costs refer to the value of maize and beans paid to hired workers or for renting work animals,

Considerable thought was given to the time valuation of family farm labor, the most important component of production costs for the survey population. Women, children under twelve, full-time students over twelve and adult children working full-time at non-farm jobs were assigned one-half the weight of full-time family male workers. This valuation is based on a basic understanding of the typical division of labor in Mexican small farm households in addition to field observations of surveyed households.

Under this system, the mean values for family labor per hectare were 36 man-days on maize plots and 55 man-days on maize/bean plots for the CC sub-group. The SARH sub-group used somewhat more family labor with means of 42 and 63 man-days for maize and maize/bean plots, respectively.

The "ongoing wage" for hired labor per agricultural task was used to calculate the monetary worth of family labor. As far as possible, calculations were based on local day-rates, which vary considerably among surveyed communities. The decision to use the "going wage" was based on the relatively high opportunity cost of family farm labor in the survey area, except among the older generation.

In Table 9, calculations are presented for median gross, net and net disposable per hectare income for the sample maize and maize/bean plots, CC and SARH compared. As the discussion of yields earlier would indicate, the CC sub-group did slightly better than the SARH sub-group in gross income from maize plots and considerably worse in gross income from maize/bean plots.

Using the first definition of net income, for which family farm labor is assigned zero value, the figures in Table 9 can be interpreted as returns to the farm household before and after subsistence consumption (human and animal). Using the second definition of net income, for which family farm labor is assigned the "going daily wage," the figures in Table 9 can be interpreted as the net profit rate, or return to farm management, and the net disposable profit rate after subsistence.

Returns to family labor are presented in Table 10. The results show, in aggregate terms, that farm income for the survey population is sufficient to "pay" a return to family farm labor equivalent to about 20% above the "going wage" (1,500 pesos/day on average). After meeting the subsistence needs of the household, however, the return to labor declines to just 10-60% of the "going wage," depending upon the crop and sub-group.

The return to family labor after subsistence is clearly insufficient to meet non-subsistence consumption expenditures, which include, in order of importance, food, clothing/shoes, health, education, transportation, house improvement, community contributions and entertainment. Therefore, family members must find employment outside the family farm to make up the deficit in farm income (see Table 11 for a breakdown of sources of income). The need for outside income is greater in periods of high inflation and especially important in poor agricultural years.

In comparing the CC and SARH sub-groups we find that the differences are not impressive. As is to be expected from previous discussion, CC farmers report better returns to labor in maize-only production and poorer returns in maize/bean production. Note, however, that the return to farm labor for maize/bean plots, even for the SARH sub-group, is below the return to maize-only plots. That is because of the substantially higher labor requirements for intercropped production, especially in harvesting.

Returning to Table 9 and the second definition of net income, for which an imputed value for family labor is included, we can compare the profit rates or returns to farm management for the CC and SARH sub-groups. The profit rate is positive in all cases, except for maize only for the SARH sub-group before subsistence, and negative in all cases after subsistence. In other words, production levels for surveyed farmers are sufficient to pay family labor the "going wage" but are insufficient to make this "payment" in addition to meeting subsistence needs.

Considering the various farm-level costs not accounted for in our analysis, the return to farm management is practically nil for the CC sub-group, strongly negative for the SARH sub-group in maize-only and still positive in maize/beans. In other words, the profit from farm "ownership" is negligible. There are, however, substantial intangible benefits, most of all the guaranteed option to allocated family labor to the production of food to meet minimal family and farm animal requirements, in addition to the possibility for asset accumulation through livestock acquisition and reproduction.

ANALYSIS OF CC IMPACT ON ADOPTION, PRODUCTIVITY AND INCOME

The previous section presented preliminary survey results comparing farm adoption behavior, farm productivity and net farm income for the CC and SARH sub-groups. More than anything, these results show how very similar the two sub-groups are in terms of these characteristics. In other words, the presence of Consultores del Campo programs and extension "técnicos" in the surveyed communities does not appear to have markedly altered targeted farm household decisions, productivity or net income.

In this section, we will briefly attempt to explain this outcome, first by discussing the internal limitations of the CC organization and second by discussing the external constraints affecting CC programs at the local level.

Internal Limitations of Consultores del Campo, A.C.

The first limitation concerns the failure of the CC research effort to generate sufficient new technologies or significant variations of older technologies. The differences in CC and SARH recommendations are rather moderate in terms of their technical and economic returns.

The CC technology generation capability has not been adequate to clearly "challenge" SARH recommendations. It relies on farmer experimentation and solicited expert advice, exclusively, without the benefit of complementary scientific research and controlled experimentation. The project's limited budget precludes investment in a full-blown FSR/OFE effort, which, undoubtedly, would lead to a set of more markedly innovative recommendations for the various micro-climates in the study area.

The CC technology extension capability does present a clear alternative to the "status-quo" extension effort. This is evident in the responses of surveyed farmers to questions regarding the quality of each technical assistance program. Farmer perceptions of the CC extension program are generally very positive as compared with generally negative perceptions of SARH extension programs in both CC and SARH communities.

Nevertheless, there is not a wide difference in adoption behavior between these two groups. We have seen that climatic, organizational and economic obstacles inhibit the effective adoption of some CC recommendations. The "técnicos," however motivated and competent they may be, have not been able to overcome substantial farmer resistance to adoption where these obstacles are present.

Finally, the motivation and competence levels of CC "técnicos" and coordinators have varied over time. There are great risks involved in selecting local farmers to serve as professional extension agents. It is an enormous challenge to train farmers with little or no formal education to master and teach scientific, technical and socioeconomic concepts to fellow farmers. "Campesinos-teaching-campesinos" does, undoubtedly, narrow the gap in local understanding and trust that is a major deficiency in most traditional extension methodologies. However, the "teaching" element cannot be taken for granted. It is not surprising, therefore, that not all of the "técnicos" have responded to this challenge with equal commitment and ability. The same can be said for the response of CC coordinators faced with their challenging responsibilities as teachers, facilitators and administrators.

The external environment

One of the principal explanations for the limited impact of CC programs on farm household behavior is the relatively low return to family farm labor as compared with non-farm employment. We have seen that the return to family labor among surveyed households was somewhat above the "going rate" for hired farm labor in a good year, 1985. In a bad year, the same farmers would be glad to cover maize subsistence needs. Consequently, family members of small farm households, especially young men, usually seek employment outside of agriculture for at least part of the year.

When CC recommendations require additional labor resources, they directly compete with alternative uses for that labor. In the survey year, for instance, wages for non-skilled construction work were 60% higher than for average farm work. The option, for some, to work in the United States at farm or non-farm jobs is also an ever-present temptation in view of the high expected returns.

Furthermore, economic returns to agricultural innovations are not certain; on the contrary, they are highly variable in rainfed agrosystems, especially under conditions of price uncertainty. Therefore, even when an innovation results in impressive yield increases, as with the case of bean insecticide use, the economic return to that innovation may be far from convincing. Surveyed CC farmers obtained higher returns to family labor, before and after subsistence, on maize-only plots than on maize/bean plots.

Finally, it should be noted that in periods of extreme economic austerity (high inflation, the phasing out of subsidies, reduced expenditures for programs for the poor), small-farm decision-making will tend to react to the unfavorable environment with "reverse behavior." That is, there will be a retraction from participation in government credit, insurance and extension programs that are no longer affordable and a retreat from the intensive use of purchased agricultural inputs.

Rural development NGOs, such as Consultores del Campo, can play a very important role in facilitating alternative development options for the rural poor. However, to the degree that such options depend upon favorable government policies, their effectiveness will be correspondingly limited. This is the key explanation for the widespread refocusing by rural development NGOs, including Consultores del Campo, toward more diversified and multidisciplinary strategies for achieving self-reliant community development.

TOWARD SELF-RELIANT COMMUNITY DEVELOPMENT

The intensive internal evaluation of Consultores del Campo in 1984, in which the "técnicos-campesinos" and 200 men, women and youth from participating small farm households actively participated, led to an important broadening and refocusing of CC objectives and strategies. The new plan calls for a change from "progressive technical assistance" toward the promotion of self-reliant rural development at the community level, with education and organization as the key components.

This change in strategy responded to the need and interest by local campesinos to engage in diverse economic activities that promised higher returns. As we have seen in our discussion of the survey data, small farmers in the region cannot hope to survive from basic grain production alone. There is great interest in finding new and profitable ways to optimize farm and community resources in order to reduce the pressure to seek employment outside of the region.

The CC "second phase" strategy combines agricultural programs with the promotion of local organizations, self-financing options and projects oriented especially toward women. Key to the success of this strategy is the ability of participating communities to "appropriate" knowledge and skills learned through Consultores del Campo and gradually incorporate them into everyday living. Toward this end, CC has helped communities to form committees for monitoring the progress of CC-promoted activities. Committees of women are established to monitor "women's" projects.

This broader rural development focus takes a "systems perspective" in its analysis of community needs. The goal is to optimize community resources, selectively utilize government and NGO institutional resources and introduce appropriate innovations in a community-directed strategy for improving overall well-being.

It is too early to say whether Consultores del Campo is succeeding in the implementation of the "second phase" strategy. Some of the programs have less than two years of experience. Nevertheless, the preliminary survey findings discussed above would generally support the organization's decision to move beyond an emphasis on maize/bean production as the primary means for improving small farm household welfare. The decision to pursue a broader rural development strategy is a sound response to local needs and the demands of the post-crisis era in Mexico.

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Table 1. Adoption of farm practices, Consultores del Campo vs. SARH.

Practice	CC	SARH	CC/SARH
Plant density/ha.	29,410	31,062	.95
	% Adoption		
Chemfert	96✓	85	1.13
Orgfert	55	66	.83
Pesticides	73✓	60	1.22
Soil Insect (85)	22	27	.81
Bean Insect (85)	41	66	.62
Other Insect (85)	68✓	47	1.45
Herbicide (85)	13	18	.72
Control tuza (85):	51	52	.98
Stake/rifle	9	40	.23
Bait	42✓	12	3.50

Source: survey data, 155 cases

Table 2. Bean yields with and without insecticide, total, Consultores del Campo, SARH.

	Kilos/ha. Beans					
	Total		CC		SARH	
	Ins	No Ins	Ins	No Ins	Ins	No Ins
Mean	154	57	115	30	181	99
Min	6	0	9✓	0	6	13
Max	600	300	420	93	600	300
Ratio Ins/No Ins (mean)	2.7		3.8✓		1.8	

Source: survey data, 155 cases

Table 3. Maize yields with tuza control, total, Consultores del Campo, SARH.

	Mean Yields: Maize/Maize – beans (Kilos/ha.)		
	Total	CC	SARH
Tuza Control			
Stake/rifle	1580/1486	2257/ 830	1426/1546
Bait	1380/1619	1579/1649✓	834/1468
None	1532/1736	1600/1657	1475/1817

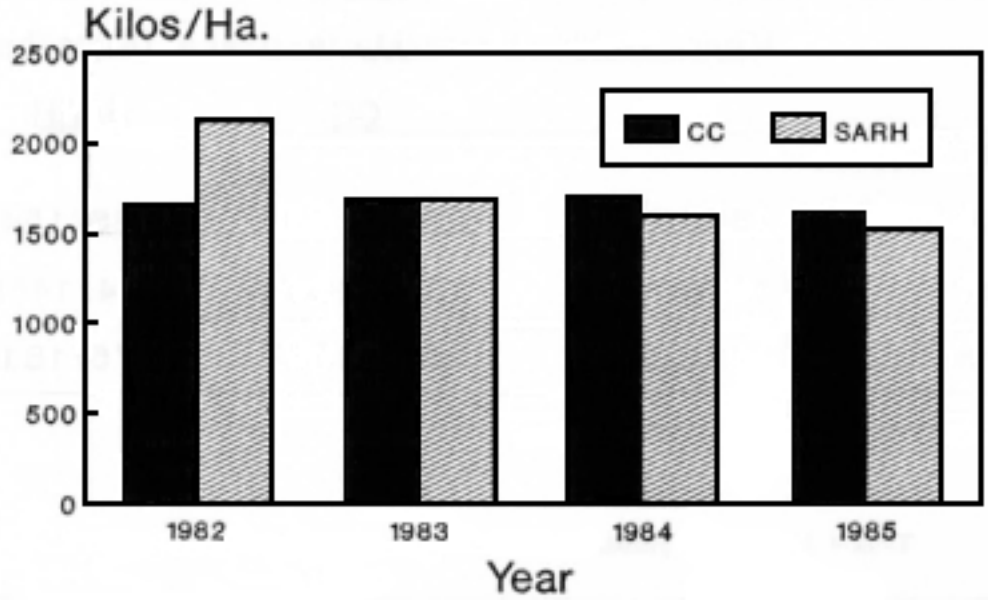
Source: survey data, 155 cases

Table 4. Maize/bean yields, kilos/ha, Consultores del Campo vs. SARH

		CC			SARH	
Yields: 1985	Mean	Min	Max	Mean	Min	Max
Maize		267	5600	1371	0	4059
	1652✓					
Maize/beans	1615	222	6000	1677	313	6500
Beans/maize	65	0	420	156	6	680
Yields: 1982-1984						
Maize						
1984	1719✓	0	4200	1609	0	5850
1983	1684	210	4200	1689	0	4533
1982	1660	274	3700	2121	0	5850
Beans/maize						
1984	61	0	250	136	0	653
1983	87	0	280	109	0	420
1982	70	0	280	129	0	300

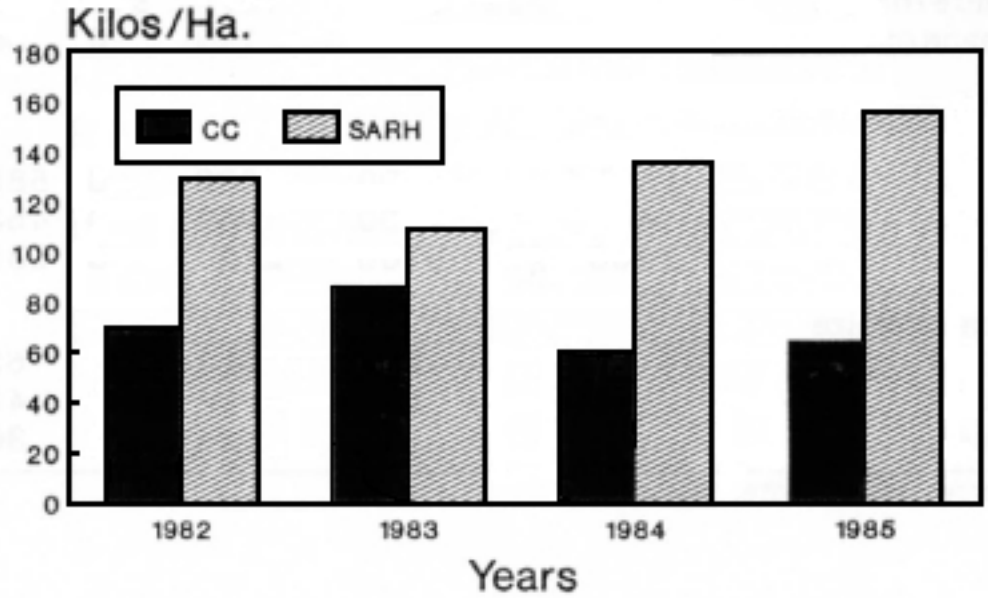
Source: survey data, 155 cases

Table 5. Maize yields, kilos/ha, Consultores del Campo vs. SARH.



Source: survey data, 155 cases

Table 6. Bean yields, kilos/ha, Consultores del Campo vs. SARH.



Source: survey data, 155 cases

Table 7. Farm income from maize only compared to maize/beans.

	mean (mex$)	Total Income median (mex$)	US$[1]
Maize only farms	349,290	241,415	604
Maize/bean farms	392,175	279,575	699

1. Median income in US dollars. Exchange rate at harvest (1/86), 400 mex$ = US$.

Source: survey data, 155 cases

Table 8. Production costs/ha, sample maize, maize/bean plots.

	Maize				Maize/Beans			
	mean	(%)	median	(%)	mean	(%)	Median	(%)
Moncost$	27,930	35	24,050	33	19,024	19	15,965	18
In-Kind$[2]	5,290	6	0	0	3,787	4	0	0
Family Labor$[3]	48,573	59	32,850	67	77,388	11	63.061	82
TOTAL	81,752	100	73,050	100	100,199	100	87,850	100

1. Does not include interest, insurance, administrative charges on loans for subset of farmers with credit (25%).
2. The monetary value of maize/bean payments made to hired workers or for yunta rental.
3. The monetary value of family labor; women, children under twelve, full-time students over twelve and adult children working full-time at non-farm jobs-.5 manday equivalent. Day rates valued at the going rate paid to hired workers.

Table 9. Gross, net, net disposable income/ha, Consultores del Campo vs. SARH sample maize, maize/bean plots.

	Maize (median-$)		Maize/Beans (median-$)	
	CC	SARH	CC	SARH
Gross Income	81,540	79,235	77,022	119,250
	(US$204)	(US$198)	(US$193)	(US$298)
Net Income				
Definition 1.	57,925	52,775	54,014	104,675
	(US$145)	(US$132)	(US$135)	(US$262)
Definition 2.	8,250	-21,518	3,787	20,236
	(US$21)	(-US$54)	(US$9.5)	(US$51)
Net Disp. Income[1]				
Definition 1.	22,841	725	14,194	53,800
	(US$57)	(US$1.8)	(US$35)	(US$135)
Definition 2.	-16,763	-61,857	-40,361	-35,448
	(-US$42)	(-US$155)	(-US$101)	(-US$89)

Def. 1 . Gross income net of all monetary production costs.
Def. 2. Gross income net of monetary, in--kind and family labor production costs.
1. Disposable net income-net income after m/b home consumption.

Table 10. Returns to family labor, Consultores del Campo vs. SARH.

	Maize		Maize/Bean	
	(median dayrate-$)			
	CC	SARH	CC	SARH
Returns to Family Labor:				
Net	1,931	1,885	1,317	1,805
Net Disposable	761	12.5	346	928

Source: survey data, 155 cases

Table 11. Source of income.

Income Source	Frequency (%)	Mean (%)	Max (%)
Sales:			
Maize	86	26	100
Other crops	43	8	25
Animals/milk	51	19	60
Wood/resin	9	5	72
Crafts	8	2	75
Sub-total		60	
Commerce/business	18	5	70
Day work:			
Farm	17	5	100
Non-farm	16	5	70
Mexico/USA	8	6	90
Sub-total		16	
Children:			
At home	33	8	90
Mexico/USA	22	11	90
Sub-total		19	

Source: survey data, 155 cases

United States
Regional Papers

THE BEGINNINGS OF CHANGE IN AMERICAN AGRICULTURE

Jerry B. Eckert

INTRODUCTION

The American agricultural establishment is slowly creeping out from behind a hide-bound, complacent faith in a fixed set of institutions and processes that have dominated agricultural programs for 50 years. Fledgling initiatives are emerging in the form of new policy and program adaptations. The concept of "sustainability" appears to be a valid addition to the conceptual set underpinning fanning systems programs. Concurrently, new clientele and new sets of practitioners are emerging as well. The US regional session developed these and related themes in a series of four quarter-day sessions.

THE FEDERAL PERSPECTIVE (SESSION I)

The opening session presented national or federal perspectives on alternative approaches to agriculture with three stimulating presentations by Charles Culver, Dixon Hubbard and Charles Francis. Apparent in all three papers was the view of rapid, even dramatic, change in American agriculture. Hubbard's paper was particularly articulate on this score. A wide range of programs and policies relating to LISA (Low-Input, Sustainable Agriculture) were described by the three speakers. Francis offered an excellent discussion of the term *sustainability,* putting conceptual flesh on the bones of a buzzword. It became obvious that sustainability and LISA have enough depth to stay with us as guiding concepts for some time. Hubbard Was explicit in stating that in LISA, USDA was delivering not a program but rather a broadly applicable concept. He then described in some depth the allocation and content of the first year's federal money supporting LISA research.

Culver summarized perspectives from the legislative branch. The disturbing thought to emerge from his remarks was that he has yet to see a groundswell of legislative (read political) support for LISA. "The concept has no champion as yet," he noted, although he personally felt that strong support was warranted. Culver was careful to note the existence and political clout of agricultural constituencies that can be expected to strongly oppose low-input initiatives. At the same time he was optimistic about new legislation that could have an impact, such as a provision now being considered to allow farmers to experiment with alternative agricultural practices or systems on set-aside land.

To summarize the opening session, the following national overview emerged:

1. Agricultural and environmental long-term trends, including the recent farm crisis, provide something of a mandate for new ideas in the approach to technology development and competitiveness;
2. At the same time, the state of flux in American agriculture opens a window where well-thought-out new initiatives might find receptivity;
3. In several ways the federal government is experimentally iterating their way toward new policies and programs that will be supportive;
4. LISA emerges as a practicable concept that will focus federal thinking as well as that of the rest of us. Further, LISA comes across as a valid extension of the FSR/E conceptual framework, compatible yet expanding;
5. At this early stage in the evolution, constituencies behind LISA are in flux and so, also, is program direction and leadership. One can expect some shaking out of this situation and a move in the near future to greater focus and fewer buzzwords.

DOMESTIC ACCOMPLISHMENTS (SESSION II)

The second session focused on domestic FSR/E accomplishments, and there were several of note. Ellen Taylor-Powell provided a detailed summary of a survey of Extension programs in 38 states with respect to their use of integrated programming. It was not a dry hole. Viewed through the overlay of integrated, systems-based, interdisciplinary expectations, a number of significant Extension efforts were found. The study establishes an interesting and useful set of summary statistics regarding the state-of-the-practice in Cooperative Extension as of about 1986.

Her results also emphasize another fact. Several of the programs identified have been operational for some time, predating the very recent explicit emphasis on integrated, interdisciplinary programs. Apparently, program planners in numerous settings have perceived this need and responded. Raising integrated programming as an evaluation focus casts their work in a new light. The same can be said for a number of international efforts that were in place before the farming systems emphasis took hold.

At Colorado State University, Utah State University and elsewhere, two parallel sets of domestic and international activities have proceeded simultaneously for many years. At CSU these are labeled fanning systems (FSR/E) and on-farm water management (OFWM). Each has its proponents and practitioners, and, at least at CSU, there are few cross-over faculty. There has been a tendency over the years to treat FSR/E and OFWM as professionally and methodologically distinct, and much debate has addressed this point.

Alan Early examined the concepts, methods and field practices of FSR/E and OFWM from the perspective of his 25 years of involvement in both. He found twice as many similarities as differences. His paper provides the conceptual basis for applying FSR/E approaches further in irrigated agricultural systems.

Two case studies were presented. In one Derrick Exner and Richard Thompson discussed a program of on-farm testing undertaken jointly by Iowa State University and a farmers' association, Practical Farmers of Iowa. The experience is important in that it demonstrates the strong role of an existing grassroots farmers' organization and how an effective partnership can be built with land grant university specialists. Their joint field work centered on the issue of sustainable agriculture.

Udai Bishnoi reported a program at Alabama A & M that has the dual objectives of income enhancement and erosion control. Working with very small$_s$ very poor farmers, the A & M team has achieved both. A number of alternative crops were introduced along with conservation practices. Incomes increased by at least 50%, and erosion nearly ceased. The enthusiasm of the cooperating farmers was captured dramatically in an excellent video that was the core of his presentation.

METHODOLOGIES FOR US APPLICATIONS (SESSION III)

This session explored the question, "Should FSR/E methodologies differ when applied in the US setting?" Back-to-back papers by Peter Hildebrand and Jerry Eckert searched for significant differences between the US and Third World environments for FSR/E programs. Hildebrand concentrated on the institutional setting from which FSR/E programs are run. Essentially the contrast was between national programs abroad and those run by land grant institutions at home. Eckert looked at differences in factors influencing farm management decision making. Both views found important distinctions that can affect program design and/or field operations. However, both concluded that the basic FSR/E approach was applicable to US agriculture. The peculiarities of a more developed agriculture and the American institutional setting, however, suggested a number of refinements and modifications to the basic FSR/E process in a US application.

Chris Andrew read a paper by O'Connor, Hildebrand and himself discussing institutional evolution as a necessary part of the FSR/E process. This thought-provoking paper developed the theory that for maximum effectiveness, the implementing (US) institutions must make significant internal changes. The proposition was supported by recent experience in Florida where a new research center was established in 1986 structured around a systems-oriented, integrated research and extension program.

Gary Weber discussed IRM (Integrated Resource Management) as an application of an integrated systems approach tied to a specific commodity subset: livestock. As with other initiatives in the US, IRM is an evolving program, the methods for which are still being refined. It appeared that there has been substantial work done abroad on livestock-based agricultural systems that could be usefully incorporated into the IRM thrust in the US. A major IRM conference is scheduled for November to continue the search for conceptual and methodological refinements.

SPECIAL TOPICS (SESSION IV)

The special topics session provided an umbrella under which to put some very interesting papers that did not easily fit elsewhere. In the first of these, Rosanna Alvarez and Wilmer Harper reported their research into the hierarchy of task preferences among rural women in Dona Ana County, New Mexico. Their work establishes that well-defined preference orderings exist, that those of females differ from those of males and that some differences can be found between task preferences and task assignments. The Alvarez-Harper paper demonstrated once again that gender issues can be as important in domestic work as overseas.

Private sector initiatives in FSR/E were represented by the Rodale Midwest Farming Systems Network, lucidly described Rhonda Janke. This imaginative program provides on-farm testing focused around farmer-identified problems in several Midwestern states. Information exchange between cooperators is an important component. Janke's presentation established clearly that there is plenty of room and indeed need, for other actors on the scene in addition to established state and federal agencies.

Finally, Fritz Senft addressed a US problem not found in the Third World: the surfeit of information available to American farm operators and the difficulty of managing all of it. This, he stated, was a significant problem facing US farmers. He presented his work-in-progress to develop an "expert system" computer package for use by small- to moderate-sized farms as a means of integrating and utilizing complex information sets for farm management.

As the day-long session closed, the conversation among participants turned to the need for much greater information sharing among US practitioners. It was obvious during the day that much is happening domestically but that many initiatives are underway or planned in relative isolation of one another.

Information on the American FSR/E scene is much like "fugitive literature" in the scientific community:

a. pieces exist here and there;
b. no one has a full set;
c. many publicly available documents suggest that much greater experimental and experiential depth lies behind the scenes;
d. networking is currently the best way of discovery, unfortunately, networking, in this context, is very much relationship specific, and many practitioners have only limited access.

The program provided a panorama that could be likened to a sea full of iceberg tips. There is much to be learned and shared from each other just as there is a great deal to be adopted or adapted from the international FSR/E experience. This is especially true at this early, formulative stage in the evolution. The participants at the US Regional Session trust that this exchange will continue and expand rapidly in coming years.

US VS THIRD WORLD RESEARCH AND EXTENSION INSTITUTIONS: THEIR EFFECT ON FARMING SYSTEMS METHODOLOGY

Peter E. Hildebrand[1]

COMPARATIVE INSTITUTIONAL SETTING

Research

Mission:

US	THIRD WORLD
Mostly conducted at Land Grant universities that have a declining sense of a development mission.	Often conducted in organizations created with a development mandate. Therefore, there should be a strong sense of a development mission.
Researchers have little sense of an institutional mission, and there is little incentive to work in multi disciplinary teams.	Researchers have more sense of an institutional mission, and there is considerable incentive to work in multidisciplinary teams.
Nature of Research	
Shrinking state and federal research budgets make grantsmanship very important and competitive.	Little or no opportunity for individual grants.
Much research oriented toward competitive grants won by professors. Grants not necessarily related and seldom integrated.	Most research based on approved program with at least some integration.
Mostly done by graduate students who carry out research in competition with course work. The graduate students' desire to finish graduate school and get a job may outweigh their desire to do "meaningful" research with farmers toward which they often have been motivated before beginning graduate school.	Carried out by scientists and technical people who are hired specifically for research.
Heavy emphasis on basic research at the PhD level. Much MS research is sub-project of PhD project. Little incentive for applied or adaptive research.	Ordinarily emphasis on applied or adaptive research.
Resources	
High fixed investment in research stations and laboratories means research is usually oriented toward their use.	Experiment stations and laboratories are often less well equipped, reducing incentive to work in them,

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Research personnel have relatively limited access to transportation because of the anticipation that they will conduct research in laboratories and on experiment stations.	Budget restrictions enforced either by the national government or the donor community mean that transportation is also usually limited.
<u>Personnel evaluation</u>	
Research faculty are evaluated on the basis of refereed publications that are easier to generate with station and laboratory research.	Personnel evaluations (where they exist) usually are not based on publications but on successful completion of applied and adaptive (on-farm) research activities.
Multiple author articles (as generated by team efforts) are less valuable in evaluations than single or double author articles; therefore, they are discouraged.	Team efforts are encouraged. Poor team collaborators receive low evaluations.
Orienting research toward publications biases the nature of research to that which is easily carried out and for which positive (and statistically significant) results are easy to predict.	Team members who have been trained in on-farm research techniques are proud of working under the difficult conditions found on farms. Adversity creates *esprit de corps* if not easy results.
Extension	
Many research personnel have joint appointments in extension.	Extension usually has little connection with research.
County extension personnel are evaluated on the basis of meetings and contacts and not on the basis of research results. Therefore, they have little incentive or budget to do the applied or adaptive research that could develop technology applicable to their counties.	Often extension agents have many tasks not related to technology development and/or diffusion, so they have little time for on-farm research.
"Demonstration plots" are sometimes used for simple research and present a potential for more formal on-farm research.	Extension agents do some "demonstrations." This activity could be modified to provide an opportunity for collaboration in on-farm research.
Extension specialists with a state-wide mandate to do applied research are too limited in budget to be able to develop technologies geared to specific areas.	Extension specialists may not exist, so there may not be any extension capacity for research.
Farmers	
Relatively few in number, thus requiring a higher proportion as collaborators in on-farm research activities.	Farmers represent a large proportion of the population, so a relatively small proportion is required for on-farm research collaboration.
Most are literate, and many are relatively well educated.	A higher proportion is illiterate, and most have little formal education.

Many small and medium sized farms are managed by part-time farmers who have full-time off-farm jobs, leaving little time for management of the farm or on-farm research.	Many also work off the farm, but mostly in part-time jobs. They could have more time to manage the farm and on-farm research,
Relatively few enterprises on the farm could leave more time for on-farm research or managing any one of them.	The myriad of enterprises precludes spending much time on any one of them for either management or research.
Farmers have come to expect change, although new technology is not always appropriate for their conditions.	Change is much less evident, and the farmers have had less relevant contact with change,

IMPLICATIONS FOR USING FARMING SYSTEMS METHODOLOGY

Research

The effect of a presence or absence of an institutional sense of mission favors the utilization of farming systems methodology in the Third World rather than in a US Land Grant university. The declining sense of mission in US Land Grant universities parallels the increasing dependence on grant funds for research. This fosters competition among researchers that in turn tends to diminish the opportunity for collaborative research.

Other than for those grants that specify applied research results, much of the research conducted at US Land Grant universities is more basic in nature and is oriented toward the completion of PhD dissertations (which are supposed to explore the frontiers of knowledge of the discipline). In the Third World, most countries cannot afford the luxury of basic research. Hence there is more emphasis on adaptive or applied research conducted by persons who are hired specifically to do it. These factors, again, favor the use of farming systems methodology in a Third World setting.

Strangely, the availability of research resources, though less decisive, also favors the use of farming systems methodology in the Third World. In the Third World, experiment stations and laboratories are often less well equipped, so there is less incentive to work exclusively in their environs than there is in a US Land Grant university office, laboratory or experiment station. The availability of transportation, however, may be more neutral. Although the Third World is chronically short of transportation resources, US researchers traditionally include little transportation in their research budgets, other than for airfare to meetings, because they are becoming accustomed to working on the station, or in their laboratories or offices.

Personnel evaluation procedures in the US are largely unfavorable for farming systems methodology. Scientists with heavy research appointments must publish a large number of refereed articles in recognized journals for survival, promotion and salary raises. Such scientists are tempted to carry out research that has a high probability of statistically significant results and to minimize the amount of time spent in "risky" research or research that would result in publications with many authors. This biases the research toward controlled experiments, or modeling with known, secondary data sets, and away from on-farm experiments and the collection of new, real-world primary data, both of which are essential in farming systems research.

Extension

The extension picture for farming systems research (and extension) is relatively more favorable for the US than for the Third World. Many research personnel have extension appointments (and vice versa) that should be amenable to applied or adaptive research activity. However, "Extension Specialists" (divided extension/ research appointments) with a state-wide mandate to do applied research are more often than not too limited in budget to be able to develop technologies geared to specific areas. Extension specialists do not exist at all in most Third World countries.

Unfavorable in both settings are constraints with extension at the county or "extension office" level. Most extension personnel are evaluated on the basis of the number of contacts and meetings they have or the number of "demonstration plots" they put out. Results of the plots or measures of technology diffused seldom enter into the evaluation process. A modification of the evaluation process would need to be accomplished in order for the effort spent in the demonstration activities to be useful for contributing to on-farm research.

Decentralized Research and Extension Centers

Many states in the US have decentralized (or sub-) experiment stations, and in some cases these are combined with the extension program. In Florida, most research and extension (specialist) personnel at these "Research and Education Centers" report to the Center Director. This type of arrangement has the potential for the utilization of farming systems methodology. One such attempt is underway at the Southwest Florida Agricultural Research and Education Center (AREC) at Immokalee, Florida. Another is being revived with a new structure at the Life Oak AREC in north Florida. However, if these stations are organized along traditional commodity and disciplinary patterns, changes to a farming systems approach will be difficult to facilitate (O'Connor, 1988).

Farmers

The role that farmers play potentially makes the utilization of farming systems methodology in the US somewhat more favorable than in the Third World. Although there are relatively fewer farmers in the US, so a higher proportion must be involved in on-farm research, most are literate and better equipped to participate actively. At the present time, many US fanners have full-time off-farm jobs that diminish their capability to undertake on-farm research. However, they manage fewer enterprises than their counterparts in the Third World, so they may have relatively more time for any one of them. Off-farm work in much of the Third World is a part time activity, but this is offset by a larger number of enterprises on each farm. In the US, farmers have become accustomed to change and expect it even though much available technology is not always appropriate to specific conditions. In the Third World, change is often much less evident, and the farmers have had even less relevant contact with new technology. However, offsetting the natural skepticism of Third World farmers to expect something good to come their way is the inclination of US farmers to expect a "salesman" (which could be an extension agent) to come by with something that *might* be good.

IMPLICATIONS FOR KIND OF FARMING SYSTEMS METHODOLOGY

In reflecting on the preceding premises and the conclusions they elicit, there is little to suggest that the basic kind of farming systems methodology should be different in the US than in the Third World. Experience, however, indicates that there would be some interesting differences required in specific techniques. For example, we found it more efficient to phone farmers for appointments, whether during the Sondeo or to review on-farm research, while we were working in north Florida. This is not possible, nor usually necessary, in the Third World. Plots in farmers' fields can become quite different when the work is by machine rather that by animal or, particularly, by hand. Biophysical differences (climate, soil type) can be relatively more important relative to socioeconomic differences in the US, but socioeconomic differences (farm size, ethnicity, full versus part time) still can be important in the US.

SUMMARY

In summary, with respect to the *research* institutional setting, the sense of mission, the nature of the research being done, the availability of resources and personnel evaluation all favor the undertaking of farming systems research in the Third World relative to the US. With respect to the *extension* institutional setting, conditions favor the use of farming systems research in the US over the Third World. This is particularly true, potentially, in states that have combined research and extension on regional experiment stations. Although farm conditions are quite different in the US than in most of the Third World, there is little to suggest that these characteristics make them any more or less amenable to farming systems research or that basic farming systems research methodology needs to be much different in the US than in the Third World.

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USING REPLICATED ON-FARM RESEARCH TRIALS TO ANSWER FARMER'S QUESTIONS ABOUT LOW-INPUT CROPPING SYSTEMS

Rhonda Janice and Ken McNamara[1]

INTRODUCTION

On-farm research has taken various forms and has been designed to meet different objectives ranging from on-farm testing of researcher's questions, to researcher's descriptions of working farms (Culik et al., 1983; Kaffka, 1984; Lanyon and Schlauder, 1987; Patriquin et al., 1986). A third type of on-farm research, that designed to allow farmers to answer their own questions, is currently receiving more attention and is being promoted, especially among groups involved in sustainable, low-input, regenerative agriculture (Anon., 1987b; Granatstein, 1988; Hergert, 1987; Thompson and Thompson, 1985).

In the past, descriptions of on-farm research projects have largely been found in international journals and farming systems symposia. Recently, reports of U.S. on-farm research projects can also be found (for example, Anon., 1987a; Bishnoi et al., 1986; Fulton et al., 1986), and in the next few years, the number of reports will increase dramatically as the results from the Low-Input Sustainable Agriculture (LISA) projects funded in 1988 become available. The appropriate role (or roles) of on-farm research in the U.S. is a question worthy of discussion (Lockeretz, 1987) and debate (McNamara and Thompson, 1987), and the question of appropriate designs for on-farm research is interesting to compare from the point of view of researchers (Barker et al., 1985) and farmers (Thompson and Thompson, 1985). In some cases, not only are farmers determining the research question to address on their own farms, but they are also testing reduced input practices in replicated experiments with the participation of a network of farmers within a state (Anon. 1987b).

The purpose of this paper is to describe the purpose, objectives, structure and methodologies used in the Midwest/Rodale on-farm research network. Experimental results may be used to illustrate points, but detailed descriptions of the experiments and results can be found elsewhere (Anon., 1988; McNamara et al., 1988; Thompson and Thompson, 1987).

BACKGROUND AND OBJECTIVES

In 1984 the Rodale Institute began collaborative on-farm research with Dick and Sharon Thompson. During 1986/87, a network of on-farm research cooperators was developed in the midwest, with 11 cooperators in nine states conducting replicated trials or establishing cover crops for trials for 1988 (Fig. 1). Currently the network consists of 14 cooperators in nine midwestern states (Fig. 2) and includes an apple producer as well as cash grain, dairy, hog, beef and vegetable producers. Day-to-day activities are coordinated by Ken McNamara, the Midwest on-farm Research Coordinator, and technical support, data analysis and linkage to the Rodale Research Center is provided by Rhonda Janke, Agronomy Coordinator.

Several farmers were interviewed in each state before selecting a cooperator for the network. Selection was based on many factors, but important ones included 1) interest in and/or demonstration of an interest in reducing fertilizer and pesticide inputs on the farm, 2) interest in on-farm research, in asking questions and motivation to lay out plots, collect yield data, etc., and 3) a willingness to have a field day at the farm on a periodic basis, be a speaker or part of a panel discussion at farmer workshops and talk about practical aspects of low-input, sustainable, regenerative agriculture to other farmers. Some farms were chosen to represent cropping systems or farming systems (and sizes) typical of their area, and others were chosen to add diversity to the network, i.e. an apple producer, so that more enterprises would be represented (not just corn and soybeans).

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The primary objectives of this network are:

1. To answer farmer's questions about low-input, sustainable cropping systems. This involves testing low-input strategies in replicated, on-farm experiments so that a farmer can rely upon more than just test-imonials when deciding which inputs he or she can cut back on, and how much.
2. To test new systems under realistic conditions. Again, the questions are determined by the farmer. In this case, both replicated and non-replicated trials may be used to test a new practice, such as no-till planting into rye or hairy vetch without herbicides or relay cropping soybeans with small grains. Screening legumes and grasses for their usefulness is another example.
3. To utilize the farmer's knowledge and skill in the development of low-input systems. Low-input cropping systems are sometimes complex, and adoption of new practices almost always involves some fine-tuning and fiddling by the farmer. Direct researcher involvement in this on-farm research provides a direct link back to the Research Center, where some of the problems that arise on the farm can be addressed in future on-station research. Also, the farmer's experience with these systems is shared with other farmers as well as with researchers as farmer workshops and field days.

METHODOLOGY

To meet the above-mentioned objectives, three types of on-farm research projects are being conducted. These include 1) replicated trials of reduced vs. standard inputs (fertilizer, pesticides, tillage), 2) unreplicated observation or screening trials to try several new cover crops to see what might work best and 3) unreplicated demonstration trials to demonstrate the feasibility of a new farm enterprise, such as organic melons, or a Voisin rotational grazing system. Moving towards low-input, sustainable, regenerative agricultural practices involves much more than simply giving up some inputs. In reality, a farmer is simultaneously adopting several new practices at the same time that inputs are being reduced. Some of these practices, such as over seeding, relay cropping, adopting a new crop rotation or adding a new farm enterprise, are best tested on small plots, on an observational basis. Once a farmer is comfortable with a new practice, the new can be tested against the old in a replicated trial, and yield differences and economics can be compared statistically as well as visually. In the case of reducing inputs, replicated experiments give farmers a sound, conservative test of the new with the old, and again, yields and economics of two or more practices can be compared statistically.

The replicated experiments are conducted using the design suggested by Thompson and Thompson (1985). This design makes the most sense for new vs. old comparisons for a North American crop farmer. The experiment is designed around the equipment with which the farmer will be planting, cultivating and harvesting. The length of each plot is the length of the field, which may be up to 1/2 mile long, in the case of the Nebraska cooperator. This length is so that the farmer does not need to turn equipment around in the middle of the field, wasting space on alleys. The width of each plot will be a minimum of two harvester widths. This allows one pass up and one back before the harvested grain is dumped into a weigh wagon or otherwise measured for yield. Plots may be wider than this if a) border rows are needed to allow for drift of spray, fertilizer, manure or seed (if over seeding) or b) if planting equipment is not matched to harvesting equipment and extra rows need to be allowed for.

Statistical analysis of these trials is a simple t-test if only two treatments are used and an analysis of variance with contrasts or Duncan's multiple range test used for mean separation if more than two treatments are used. Farmers are encouraged to plant six replications of each treatment in a randomized block design. More replications have been planted in some cases. Whenever possible, the number of treatments is kept to a minimum. For field day purposes, "side-by-side" comparison of an old vs. a new treatment has its appeal and limiting the number of treatments to two or three also keeps field variability to a minimum. With large plots designed to accommodate existing field size and equipment, a three by three factorial type of experiment is logistically unrealistic.

The types of data to be collected are primarily field operations and observations of the weather, baseline soil tests and final yield. In the case of a reduced fertilizer experiment, soil tests for that nutrient (i.e. nitrogen) and plant tissue nutrient status tests would also be conducted. If the objective of the trial is to compare two weed control methods, a weed count or rating would be taken at some point in the growing season to document and quantify differences. The farmer cooperators are primarily responsible for planting the experiment, recording field observations and weather, and final harvest. Rodale staff assists with final harvest when possible and also help out with some of the soil, tissue and weed sampling. If additional data are needed by collaborators, as in

the case with a joint project with Michigan State researchers, the researcher is responsible for collecting that data (soil samples for herbicide residue in this case).

Rodale staff collates the results from the cooperators and publish a summary report at the end of the year, as well as articles in *The New Farm* magazine, a Rodale Institute publication. Farmers also present their results at field days held on their farms and at winter workshops sponsored by the Regenerative Agriculture Association and others. Each winter, a two-day meeting is held with all of the cooperators and Rodale Institute and Rodale Research Center staff to plan next year's trials. General results and methodology are discussed at plenary sessions, and then next year's trials are planned in small group discussions. These individualized sessions always start with a question to the farmer... "Well, what would you like to do next year?"

DISCUSSION AND SUMMARY

The Relationship of On-farm Research to Work at the Rodale Research Center (RRC).

Trials at the Research Center and the Midwest on-farm research are complementary. At the Research Center, generally three types of trials are conducted.

1. Unreplicated screening trials, such as when screening new legume species for use as overseeded species into corn, soybeans or wheat. These trials are characterized by a large number of treatments, small plots and a low probability of success since completely new species or species combinations are being tried. A scaled-down version of this is suitable for on-farm research, with species chosen from RRC trials to increase the probability of success on the farm.
2. Replicated, factorial design experiments, designed to test one or two factors at a time along with (heir interactions. An example might be several types of tillage (plow, ridge, no-till) across several cover crop species. In these experiments, medium-sized plots are used to accommodate RRC field equipment, and plots are machine harvested. An average of nine or ten treatments will be compared with four or more replications. These experiments generally run for one or two years and incorporate things that work from screening trials into them.
3. Long-term, replicated, cropping systems experiments are conducted to make comparisons among whole cropping systems. In these experiments several factors may necessarily be confounded, so that realistic comparisons can be made. For example, a "conventional" corn plot may have fertilizer and pesticide inputs, an early planting date and no cover crop prior to planting, and the "low-input" corn will follow a red clover plow-down, be planted 7-10 days later and receive no fertilizer or pesticide inputs but be rotary hoed and cultivated. Two experiments are currently on-going, one with nine treatments and eight replications, and the other with 13 treatments and six replications. Large plots are used, and large amounts of data are collected from each plot. These experiments would be unrealistically complex for a farmer to run, since it takes one or two researchers plus the operations crew to manage each of these trials at RRC.

In addition to these three types of trials, basic data are gathered from all trials to address basic questions related to nitrogen cycling, crop-weed interactions and crop-tillage-insect interactions. Except for the legume screening trials, none of the work at RRC overlaps with the on-farm trials significantly. Even the screening trials are complementary in the sense that dozens of potential legumes will be narrowed down to five or ten winter hardy, vigorous, winter annuals, and then farmers can test them under their conditions, varieties, planting dates, etc.

Information from farmer's trials is useful to RRC researchers in setting priorities for systems to test, tillage regimes to try, etc, but the objectives of the farmer's trials are still different than the objectives of trials conducted at the Research Center. A farmer wants to know if a new practice will work as well as the old and be as profitable. Both treatments in the experiment will have a high probability of success. In the RRC trials, we feel compelled to try risky practices, test several planting dates, seeding rates, etc. so that farmers can learn from our experiences and then fine-tune their systems, hopefully with less risk.

"We aren't talking about agriculture in a can anymore."

On-farm research is especially valuable for researchers and farmers interested in sustainable, low-input, regenerative farming. Adoption of new practices while reducing inputs is complicated business and requires new management skills, if not a higher level of management altogether. Cover crop species, crop variety, residue level in the field, timing of planting, timing of tillage operations and weed level all interact with the usual soil

and weather variability to make getting all of the components working together complicated. Slight variations in equipment adjustments from operation to operation can also make or break a system. Fiddling with these systems on each farm by individual farmers is the primary way to get them to work.

In addition to a biological transition within the soil from conventional to sustainable or low-input farming, many farmers also experience a learning curve phenomena. Because of this, on-farm research and experimentation is valuable. Fine-tuning is a necessary part of "getting these systems to work," and a well-designed experiment can help farmers fine-tune things such as the appropriate nitrogen rate following a green manure, or whether a band of herbicide is needed in addition to cultivating once ridge tillage is adopted.

A third way that on-farm research contributes to the adoption of sustainable agriculture practices is that it is a way of generating and passing on "information-intensive" technologies. These practices or systems are not easily commoditized and are not sold over the counter at the farm supply store.

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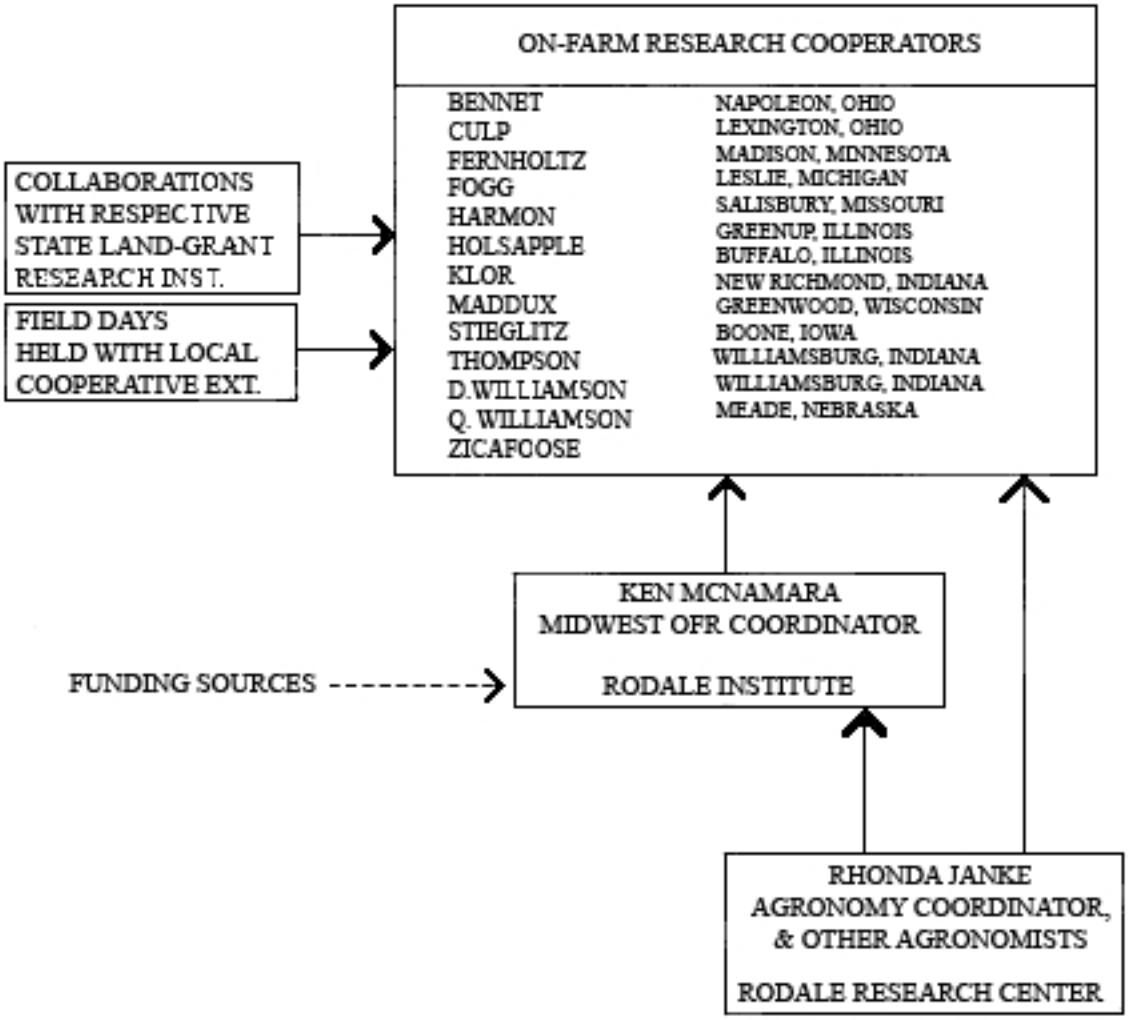

Fig. 1. Organizational diagram of Rodale's midwest on-farm research network.

Fig. 2. Location of the Rondale Research Center and the midwest on-farm research cooperator's farm.

INTEGRATED SYSTEMS PROGRAMMING IN U.S. EXTENSION: ACCOMPLISHMENTS NATIONWIDE AND RESULTS FROM TEXAS

Ellen Taylor-Powell[1]

INTRODUCTION

From the mid 1900s the rapid growth in knowledge and demands for scientific approaches to agricultural problem solving led to increasingly specialized knowledge bases. In diffusing this specialized information, extension played a critical role. Adoption of technologies equated with increased profits helping to explain extension's move to a strong technology transfer orientation (Johnsrud, 1987). Yet this increasing specialization moved extension away from the real problems facing people.

The impact of the global economy and the crisis faced by U.S. producers--and the rural economy as a whole-
-in the 1980s showed that increased production no longer equated with profits nor were the problems facing producers finite, discreet and individual. In response, the Extension Service-U.S. Department of Agriculture (ES-USDA) undertook a national initiative, committing 36% of its resources over four years to enhancing agricultural profitability and competitiveness. The Extension Committee on Organization and Policy (ECOP) in 1984 recommended that one of the key educational methods that the Cooperative Extension System (CES) needed to use was an integrated systems approach employing teams of staff in integrating production, financial and marketing strategies to achieve maximum economic returns, not maximum output (Bolen and Lucas, 1984).

As Extension Services around the country have moved to a systems approach in addressing the pressing concern of agricultural profitability and competitiveness, different applications have developed. Many terms and types of programs fall under the label of integrated systems programming. The objective of this paper is to bring some clarity to the concept and practice of integrated systems programming in U.S. Extension. Using the results of a national survey undertaken in 1987 of 140 integrated systems programs in agriculture and natural resources from 38 states (Lippke et al., 1987), a typology of integrated systems programs is presented. Also, results from seven case programs in Texas are examined to indicate the impact of integrated systems programs on farm profitability and the Cooperative Extension System.

FINDINGS

Integrated systems programs have two primary characteristics: they are problem solving programs, and they are team programs. Each aspect offers unique considerations to program evaluation.

Problem Solving Programming

Past extension educational efforts in agriculture have consisted mainly of delivering departmental research and component technologies largely independent of one another. Such programs are said to be discipline- or technology-driven. In contrast, integrated systems programs are problem-driven. The program development process begins with identifying and defining "real problems" as perceived by the key stakeholders. This derivation in real problems is consistent with the recent Futures Task Force report and the issues programming initiative in U.S. Extension. The educational objective in extension is being reaffirmed as solving problems through education rather than the more static concept of education as knowledge transfer (Futures Task Force, 1987; Issues Programming in Extension, 1988). However, the critical and often ambiguous beginning point is the problem identification process. Identifying and defining the problem determines the system boundaries, the content of the educational intervention and ultimately the long-term impact of the Extension program.

What Are the Problems Defining Integrated Systems Programs?

As seen in Table 1, the majority of the studied programs defined the problem situation as a commodity- or resource-specific problem, reflecting the specialized, mono-culture nature of U.S. production systems. Few of

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the programs, about 19%, addressed the total farm, integrating the household or off-farm system within its problem-solving mission. This may be due to programmatic separation in U.S. Extension between production (agriculture) and family (home economics) domains.

Either problems emerged and then extension faculty representing relevant disciplines joined together to address the critical need or individuals joined together by virtue of their interest in a discipline or commodity and then found a problem to work on. The actual location of problem origin seemed less important than ownership of the problem. The critical factor was that the identified problem was perceived as a "real" problem by all the key stakeholders (policy makers, team members, county agents and/or clients) who were willing and able to commit resources to its resolution. However, commitment to the problem and program were more common if the problem stimulated faculty to join together.

While the content of the programs was as varied as the states, four major, underlying problem situations were evident in the studied programs: managerial improvement, information/technology development, information dissemination or production diversification. These problems form the typology as seen in Table 2.

Management improvement. The underlying problem situation of programs categorized as managerial improvement was that producers lacked the information and/or skills to effectively and efficiently manage their production system for a profit.

These programs were premised in the assumption that good management was the key to profitability in agriculture. Generally, programs focused their content on production and/or economic management.

Most frequently, programs defined the management constraint in terms of production management. These programs included such educational content as optimum production management practices, timeliness of management practices, integrated packages of recommendations and production economics. On-going IPM (integrated pest management) programs were placed in this category as they focus on substituting good management for costly inputs. IPM programs have, for many, been the prototype of integrated systems programming.

Programs that prioritized the constraint as a financial management problem featured farm business techniques: the use of computer decision aids, strategic planning, recordkeeping, enterprise analysis and other financial management techniques. The objective was to develop producer capabilities in economic decision making with the skills to apply in any variety of situations. Often these programs began with the producer-with an understanding and prioritization of producer goals for the production system as a whole, a commodity or land. Several of these programs also included family resource management and stress and crisis management in the program of work.

These programs might be characterized as "Information exists; it just needs to be integrated and adapted to the production system." These programs featured adaptive research, demonstration and education.

The Total Ranch Management program in Texas is an example of an integrated systems program focusing on improved management. The intent is to combine specific production technologies with improved decision making in a total ranch context. It was developed to "help ranchers better understand their total operation, identify needed responses, and improve management skills... (it) is an approach that utilizes management tools to help a rancher determine where he is, where he is going, and how he is going to get there" (White, 1988).

The program itself consists of an in-depth eight-day workshop and follow-up ranch visits with participating producers. The core team consists of district-based extension specialists in livestock, range, wildlife and agricultural economics.

Information/technology development. Another group of programs was classified as information /technology development. The underlying problem situation in these programs was that extension lacked the research-based information or site-specific information to answer current producer questions and problems. These programs were initiated to create knowledge and information where voids in the existing knowledge base existed. Often, these programs relied on applied research and on-farm trials to generate locally specific data bases and production alternatives.

The distinction is made here between applied and adaptive research. Applied research indicates the generation of knowledge: creating new knowledge of practical and direct use. Adaptive research, in contrast, indicates *modifying* existing knowledge: adjusting given technologies to local environmental conditions, needs and circumstances of producers.

These applied research programs conducted by extension might be compared to the FSR/E programs in other parts of the world. They involved the generation of information and/or relevant technologies through on-farm trials involving heavy producer participation. These programs might be characterized as "We don't have the information to answer the questions being asked."

The Interdisciplinary Wheat-Stocker Program in Texas is an example of this type of applied integrated systems program. Whereas wheat production for grain had been the primary enterprise in the Rolling Plains region of Texas, a decline in grain prices and land values and concurrent changes in the regional credit situation meant that producers had to consider both stocker and grain returns to sustain the farm operation. Producer questions began to focus on how to obtain optimum profits from the wheat-stocker system as a whole, not just one component of it. Extension did not have the answers. Existing information was specialized; new varieties and crop/livestock management techniques had to be investigated.

The Texas Agricultural Extension Service responded with an intensive three-county program using on-farm trials to investigate wheat and triticale varieties and effects of various production and grazing management options on grain, forage and stocker yields. The program has involved a core team of district-based specialists in agronomy, animal production, entomology and economics, county agents in three counties and farmer-cooperators. On-farm work and close cooperation with the farmer cooperators have been the foundation of the program. In the words of a specialist team member, "This is a research project in that we are breaking new ground and adding to the knowledge base."

Perhaps most noteworthy, this project required an inductive process of knowledge generation—starting with the production system and understanding it to build knowledge. This may be contrasted to the more common, deductive mode of extension educational programming in which the educational intervention is one of transferring existing knowledge to help producers solve their problems.

Information transfer. Another category of programs was labeled information dissemination since these programs saw the more immediate need as one in which clientele didn't know or, for other reasons, were not adopting the research information. The assumption was that research-based information existed and could be usefully applied by producers. But to be useful to producers, the components related to the problem needed to be covered and interwoven in the educational programming.

These programs might be characterized as "We need to deliver the research-based information that exists on all aspects of the problem and educate our clientele." Program emphasis was on dissemination versus adaptation or creation.

Because these programs appeared so similar to traditional extension programs, it was felt that they had the greatest potential to be mislabeled as integrated systems programs. One of the observations from the national survey was that many integrated systems programs appeared to be multidisciplinary rather than interdisciplinary efforts.

Alternative systems. While very few in number, some integrated systems programs required a separate classification as alternative systems programs. The underlying problem in these programs was one of unsolvable system constraints. These programs were involved in helping the producer evaluate and try new enterprises, alternative crops or alternative uses of land. These programs used methods and strategies found in the information/technology development programs, but the objective of the program was somewhat different; rather than seeking to generate answers to questions related to optimizing an existing production system, these programs were aimed at designing and/or implementing new, alternative systems.

These programs might be characterized as "We need something totally new here."

Team Programming

The other major characteristic of integrated systems programs in U.S. Extension is that these programs are seen as "team programs." But, what does "team programming" mean? How are the problems being defined in terms of disciplinary representation? How "integrated" are these programs?

In the surveyed programs, integration was found to occur in a variety of ways:

1. Disciplinary integration: across disciplines and within and across program areas (administrative extension units of agriculture, home economics, community development and 4-H);
2. Staffing integration within extension and with staffs outside extension;
3. Geographic integration within and across administratively defined geographic units;
4. Integration among extension, research and producer.

Disciplinary integration. From the national survey, Table 3 shows that the agricultural economists were found most frequently, perhaps not surprising given the study focus on programs enhancing agricultural profitability. Biological scientists more frequently served as team leaders in the surveyed programs. Again, these results show that few home economists or other social scientists were included on these program teams. Few of the programs showed cross-program area integration.

Staffing Integration. More than two-thirds of the 140 surveyed programs included representation from three or more staff categories. Extension specialists most frequently were found as team members (Table 4). Some what over one-half of the programs included a county agent, and just less than one-quarter included a producer on the program team, though many claimed that including county agents and/or producers was an important touch with reality.

Research-Extension-Producer. One-third of the programs included staff members representing research or a dual extension-research appointment. Thirty-one percent of the respondents indicated that the extension-research interaction in the program was high, though this often meant that the program used research-based data or methods. Only 17% of the respondents listed a gap between research and extension as a constraint to integrated systems programming.

Geographic Integration. About two-thirds of the programs were statewide efforts, and another one-quarter were multi-county programs. Programming across geographic areas, which in Extension means combining county staffs and/or using regional staffs, reflects actual problem situations that are not defined by administrative boundaries and often require the pooling of resources for effective resolution. Regionally based Extension staff appeared to be in the prime position to conduct integrated programming because they were housed with other disciplines, the problems they addressed were multifaceted, and they did not operate under the disciplinary expectations of department-based faculty.

Inventory of Results from Texas

Based on what these programs are, it is more possible to evaluate the effect integrated systems programming can have on agricultural profitability. Extension is generally concerned with and accountable for positive changes in clientele. Yet integrated systems programming, like FSR/E, is having an effect on the extension organization and the way in which extension does its business.

Following Bersten's (1982) discussion on final versus process results, Table 5 indicates the type of results generated from integrated systems programs. Final or end results refer to improvements in agricultural profitability leading to improved human welfare. The producer is the beneficiary. End results may also be seen as accomplishing the problem solving orientation of integrated systems programming—solving problems through acquisition of knowledge, skills and viable practices. The national survey of integrated systems programs did not solicit specific information concerning the extent to which the integrated systems programs were enhancing sustainable agricultural systems. Certainly, however, many of the programs were grounded in the efficient management of on-farm resources to substitute for external or costly inputs. Sustainability may need to be seen as the real and final indicator of the problem solving success of the program.

Process results, on the other hand, refer to the team programming characteristics of integrated systems programming and the building of capabilities and interactions needed to provide viable educational efforts. Such abilities may include (1) interdisciplinary collaboration-openness to working with and appreciation for other disciplines, (2) efficient and effective use of resources—pooling resources over larger areas and with others inside and outside extension, (3) building partnerships with producers, industry and research and (4) increased staff competencies.

Again, the sustainability of integrated systems programs as an extension programming approach may be the final indicator of success. The national survey of 140 programs indicated that integrated systems programs were currently existing without the infusion of additional resources. In fact, members in only 26% of the programs had been provided release time from other obligations, and only 56% of the programs had been provided an operating budget. It would seem that integrated systems programs have existed and will continue to exist regardless of any addition of external inputs. However, if integrated systems programming is to become institutionalized on a wider scale, then the extension system must make a commitment in personnel, time, financing and administrative invigoration. Attitudes of administrators, department heads in particular, may be as critical as any factor to the future of interdisciplinary programming. The levels or subsystems not being addressed in integrated systems programs and the reasons for and implications of their exclusion need to be clear.

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Table 1. Scope of program activities (n = 140 programs).

Scope		Percent of programs
Single crop		30.7
Single livestock		25.0
Multiple enterprise[1]		18.6
Multiple crops		17.8
Natural renewable resources	4% one resource 1% multiple resources	5.0
Multiple livestock		2.9

[1] Multiple enterprise includes more than one commodity area, e.g. forage and beef production; total farm; dairy and field crops.

Table 2. Typology of integrated systems programs.

Type	Problem	Process
Managerial Improvement	Producer lacks management skills	Adaptive research Demonstration
Information/Technology Development	Extension lacks research-based information	Applied research on-farm trials
Information Transfer	Producer lacks information	Dissemination
Alternative Systems	Unsolvable system Constraints	Applied research Development

Table 3. Representation by discipline of team members.

Discipline	Percent of programs	Discipline	Percent of Programs
Agricultural Economics	70.0	Range Science	10.8
Agronomy	58.3	Forestry/Natural Resource	10.0
Animal Science	52.5	Agrometerology	9.2
Entomology	43.3	Wildlife	9.2
Agricultural Engineering	38.3	Home Economics	7.5
Adult, Agricultural		Community Development	5.0
and/or Extension Education	34.7	Rural Sociology	4.2
Plant Pathology	34.2	Hydrology/Irrigation	4.2
Agricultural Communications	29.3	Aquaculture	2.5
Horticulture	23.3	Recreation and Parks	1.7
Veterinary Science	20.8	Sea Technology	0.8
Computer Science	14.2		

Table 4. Staffing integration.

Category	Percent of programs
Extension specialist	95.3
County extension staff	58.5
Extension program leaders	37.4
Research	33.6
Extension specialist supervisor	27.1
District extension supervisor	24.3
Producer	24.3
Government	20.6
Producer organization	19.6
Other	19.6
Agribusiness	14.0

Table 5. Results Inventory from Integrated Systems Programs.

END RESULTS: Beneficiary = clientele

Problem solving programming

1. Information/techniques
   e.g., development of appropriate recommendations/technologies; computer models; location specific data bases; environmental viability; production evaluation information

2. Knowledge/skills
   e.g., decision making skills; management skills

3. Practice
   e.g., application of recommended practices; evaluation and nonadoption of unliable practices; alternative land uses; increased yields/decreased losses/decreased costs

4. Sustainability

PROCESS RESULTS: Beneficiary = Extension Organization

Team Programming

1. Interdisciplinary cooperation
   - increase in numbers participating in interdisciplinary programs
   - appreciation for integrated subject matter
   - changes in way staff approach problems and each other
   - reallocation of resources to team programs

2. Geographical cooperation
   - increases in multicounty/regional programming
   - pooling of resources, more efficient use of resources

3. Partnerships and nonextension collaboration
   - improved dialogue and Interaction among producers and Extension-industry commitment
   - linkages with new and/or different institutions

4. Increased competence of extension staff - technical skills
   - technical skills
   - people skills

5. Strengthen research-extension interface
   - Identification of needed research
   - verify research recommendations
   - accumulate farm/ranch level data
   - collaboration and feedback within Land Grant University

6. Increased visibility/legitimacy of Extension
   - interpretation of extension to different audiences
   - statewide recognition of problems and alternative solutions

7. Sustainability

Global Papers:

FSR/E Accomplishments in the Field

IDENTIFICATION OF RESULTS OF FARMING SYSTEMS RESEARCH AND EXTENSION ACTIVITIES: A SYNTHESIS[1]

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with assistance from
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INTRODUCTION

The purpose of this study was to review, analyze and document the results of Farming Systems Research and Extension (FSR/E) projects/programs that have been implemented worldwide. Funded by the United States Agency for International Development, this study focused on the factors that affect sustainability of FSR/E within national agricultural research and extension systems. Emphasis was given to the degree to which externally funded FSR/E projects have assisted in institutionalizing the FSR/E approach into these systems and the extent to which governments will support these activities. The study relied on field case studies in Indonesia, Guatemala, Botswana and Costa Rica and a secondary review of FSR/E programs in 23 other countries. Overall, this review covered 16 countries in Africa, 7 countries in Latin America and 4 countries in Asia. Countries included in the secondary review were Brazil, Burkino Faso, Ethiopia, Gambia, Honduras, Lesotho, Mali, Malawi, Nepal, Niger, Nigeria, Panama, Paraguay, the Philippines, Somalia, Swaziland, Thailand, Tanzania, Sudan, Zaire, Zambia and Zimbabwe. The FSR/E activities of the Caribbean Research and Development Institute were also reviewed. Key topics addressed in this study within the context of institutional sustainability included organizational structure, training content of FSR/E programs, process of technology assessment, linkages with commodity research programs, extension, agricultural support systems, facilities of agriculture and other government programs, networking and information dissemination. The. information presented in this study was derived from interviews with government administrators, agricultural scientists, technical assistance teams, USAID personnel and consultants, as well as from field observations and secondary data. Approximately 120 interviews were conducted.

This paper outlines some of the major institutional impacts of FSR/E projects/programs as well as constraints to implementation and major lessons learned. It is complementary and builds upon the AID/PPC/CDIE study conducted by Byrnes (1988). Before proceeding with this discussion, it is necessary to first provide a general overview of the FSR/E concept used for the purposes of this study.

GENERAL OVERVIEW OF THE FSR/E CONCEPT

Farming Systems Research and Extension (FSR/E) is an approach to agricultural research and extension that deals more effectively with the problems of low resource agriculturalists. This approach was developed in the 1970s in response to the observation that groups of small-scale farm families were not benefiting from mainstream agricultural research. Although a number of terms and concepts have been used over the last 15 years to describe this approach (e.g., FSR, FSR and D, FSR/E, FSIP, FSAR and OFR/FST), there is now general consensus on the basic assumptions, methodologies and objectives. FSR/E is used here because it explicitly addresses the need for linkages among researchers, extension workers and farming systems (Poats et al., 1986).

A good definition of FSR/E has been provided by Shaner et al. (1982):

> …an approach to agricultural research and development that views the whole farm as a system and focuses on: 1) the interdependencies between the components under control of

[1] Funded by USAID, Science and Technology Bureau, Office of Agriculture and USDA OICD.
[2] Office of Arid Land Studies and Bureau of Applied Research in Anthropology, respectively, University of Arizona, Tucson.

members of the household and 2) how these components interact with the physical, biological and socioeconomic setting and by the farm families' goals and other attributes, access to resources, choice of production activities and management practices.

KEY ATTRIBUTES OF FARMING SYSTEMS RESEARCH AND EXTENSION

The major attributes and basic assumptions embodied in the FSR/E approach are the following.

1. FSR/E is farmer oriented - FSR/E targets small-farm families as the clients for agricultural research and technology development. It involves an emphasis on farmers' priorities and tapping the "body of knowledge" possessed by farmers.
2. FSR/E is holistic - FSR/E views the farm in a holistic manner and focuses on interactions between components. A comprehensive view is taken of both human and natural environments of the farm. Research focuses on production subsystems, but the connections with other subsystems are recognized, and evaluation of research results explicitly takes into account linkages between subsystems (Baker and Norman, 1986).
3. FSR/E is a dynamic, iterative and problem-solving approach - FSR/E first identifies technical, biological and socioeconomic constraints at the farm level and then proposes technologies or practices that are feasible for targeted farming households to adopt to alleviate constraints. Adjustments are made in technology design as understanding and communication with small farmers improves.
4. FSR/E is interdisciplinary - Collaboration among agricultural scientists of various disciplines and social scientists is needed to understand the conditions and constraints under which small farmers operate and to develop or introduce improved technologies suitable to those conditions.
5. FSR/E complements mainstream commodity and disciplinary agricultural research; it does not replace it - FSR/E draws upon the body of knowledge of technologies and management strategies generated by basic and commodity research programs and adapts them to specific environments and socioeconomic circumstances. FSR/E also provides a feedback mechanism for shaping priorities for basic and commodity research programs.
6. FSR/E recognizes the locational specificity of the technical and human factors - Farmers are often grouped on the basis of ecological and technical differences to facilitate technology transfer (Lightfoot, 1986). These groupings are often called recommendation domains. Once grouped, the constraint most limiting to each group becomes the focus of research.
7. FSR/E tests technologies in on-farm trials - On-farm experimentation allows for farmers and researchers to collaborate, provides a deeper understanding of the farming system among researchers and allows for the evaluation of the technologies under the environmental and management conditions that will be used.
8. FSR/E provides feedback from farmers - FSR/E provides feedback from farmers regarding their goals, needs, priorities and criteria for evaluating technologies. This feedback is directed to station-based agricultural researchers as well as to national and regional policymakers.

STAGES OF FARMING SYSTEMS RESEARCH AND EXTENSION

There are four generally recognized stages involved in the FSR/E approach that can be delineated as follows (taken from Norman and Collinson, 1985).

1. The descriptive or diagnostic stage - During this stage, the farming systems are examined in the context of the total environment. Researchers determine the constraints farmers face and ascertain the potential flexibility in the farming system in terms of timing, slack resources, etc. An effort is also made to understand the goals and motivations of farmers that may affect or influence efforts to improve the farming system. During diagnosis, various methods of informal, formal, quantitative and qualitative data collection are used.
2. The design or planning stage - During this stage, a range of alternative intervention strategies are identified that may be appropriate in dealing with the constraints delineated in the descriptive or diagnostic stage (Gilbert et al., 1980). At this stage, heavy reliance is placed on obtaining information from the "body of knowledge" of past research. This information is derived from experiment-station-based re-search, researcher-managed and -implemented on-farm trials and the knowledge of farmers. This stage

involves ex ante evaluation of a technology or practice with regard to technical feasibility, economic viability and social acceptability for a targeted area.

3. The testing stage - During this stage, a few potential recommendations derived from the design stage are examined under actual farm conditions. This is done to evaluate the suitability and acceptability of the improved practices in the existing farming system. This stage usually consists of two steps: 1) researcher-managed but farmer-implemented tests and 2) testing totally under the control of the farmers.
4. The recommendation and dissemination (extension) stage - During this stage, successfully tested technologies or practices are made available to other farmers with similar circumstances.

In practice, there are no clear boundaries between the various stages nor are the stages necessarily linear. The research process is recognized as being dynamic and iterative, with linkages in both directions. Research staff will be designing some technologies and testing others, while new problems will need to be diagnosed as our understanding of the farming system becomes more fine tuned.

RELATIONSHIP BETWEEN FARMING SYSTEMS RESEARCH/EXTENSION AND FARMING SYSTEMS APPROACH TO INFRASTRUCTURE SUPPORT AND POLICY (FSIP)

The primary objective of FSR/E is to improve the well-being of farm famines by increasing the overall productivity of the farming system in the context of both private and societal goals, given the constraints and potentials of existing fanning systems (Norman and Collinson, 1985). Productivity can be improved by the development of relevant technology (FSR/E) or the implementation of appropriate policy and support systems (FSIP). It is important to understand the differences, interrelationships and complementariness of these two approaches. FSR/E is a research strategy that is often project focused and usually involves the development and dissemination of improved agricultural practices and/or technologies at the farm level. Thus, the principal product of FSR/E is technology, and the primary clients are limited-resource farmers (Hildebrand and Waugh, 1983). FSIP, on the other hand, is an approach to small-farm development planning that operates at a more macro level than FSR/E and attempts to analyze and influence policy and/or the progress of institutions that may affect small farmers. The principal product of FSIP is information, and the primary clients are policymakers and managers of services and infrastructure (Hildebrand and Waugh, 1983).

Operating within this conceptualization of FSR/E, the study attempted to measure the impact of this approach in 27 countries. These findings are discussed below.

IMPACT OF FSR/E

There are numerous problems associated with measuring the technical impact of FSR/E's contribution to small farmer development. As Baker and Norman (1988) point out, there are three boundary issues that confound such assessments.

1. The relative contributions of conventional research and FSR/E are not separable since they are complimentary activities.
2. The adoption of technologies depends upon a wide range of circumstances, including the performance of support systems that are not under control of the FSR/E teams.
3. Because FSR/E approaches encompass technological developments and institutional change, significant results are not realized for 10 to 25 years.

Many donor-funded FSR/E programs define their project goals in terms of an increasing flow of benefits to the low-resource farm sector. However, farm-level and household-level impacts of the FSR/E approach are not easily measurable. The process of generating, testing and disseminating technological alternatives is time consuming and usually exceeds the temporal boundaries of any given FSR/E project. Due to these problems, this study has chosen to concentrate on major issues associated with the institutionalization of FSR/E programs in national agricultural research and extension systems. A fundamental assumption underlies this synthesis: namely, that the FSR/E methodology must generate institutional innovation before technical innovation and small farmer development can occur. Technical change on small farms is a direct result of successful implementation and incorporation of the FSR/E approach into national research and extension organizations. The process of institutionalization is dynamic and can take many forms. On the other hand, the adoption of basic

FSR/E principles is a measurable impact that can be assessed within the time frame of specific projects. Therefore, although technology transfer—with its positive implications for national and household development goals—should be seen as a long-term, given effect of an FSR/E approach to research and extension, the incorporation of the methodology within national organizations is the measurable, shorter-run impact of both national and donor-financed investment in the agricultural sector, especially with regard to small, resource-poor farms.

The following discussion presents a common evaluational framework for assessing the impacts of FSR/E programs. The theme of institutionalization is systematically examined in terms of concrete, manifested FSR/E components in national agricultural bureaucracies. "Institutionalization" is defined as the process of integration of FSR/E methods and principles into the national research and extension system. The individual criteria, or themes, discussed here represent what Deborah Merrill-Sands (1988) has called "intermediate products" of FSR/E integration. These "products" are the institutional innovations that have occurred at the level of agricultural bureaucracies and should be seen as indicators of the total gradual process of agricultural change. In those cases where the FSR/E experience has had some time depth to develop a more solid institutional foundation, it is expected that the methodology will have yielded concrete benefits at the farm level, such as the identification and diffusion of improved technologies.

We have identified nine distinct themes of FSR/E institutionalization, each of which is examined within the context of specific country national agricultural research and extension systems. These include the organizational integration of FSR/E; cost sharing in the FSR/E program; commonality of approach; differential components application of the FSR/E approach; short-term and long-term training; institutional and international linkages; farmer participation; information dissemination and public policy; and impacts of technology transfer. The findings pertaining to each of these themes are presented below, summarized by region.

Organizational Integration of FSR/E

A major difficulty in the integration of the FSR/E approach into national research and extension organizations is that it does not fit well within existing organizational structures. That is, rearrangements must be made within a national agricultural bureaucracy in order to accommodate the interdisciplinary, cross-institutional and farmer-focused orientation of FSR/E. To obtain optimal impacts, the FSR/E activities would be incorporated into all the departments of the existing research and extension structure. For example, commodity-based, applied research programs would have an FSR/E component that both identified research priorities and selected among technological alternatives at farm level. In reality, national organizations have shown great variation in their respective types of structural adaptation to the FSR/E approach. This variation can be interpreted as a continuum of effective integration ranging from the least incorporated, virtually isolated FSR/E programs to the fully institutionalized. Some points along this continuum-starting with the least integrated are identified as follows:

- an FSR/E project within a Ministry of Agriculture or national research service that represents a parallel activity to ongoing research and extension programs;
- an FSR/E division or department within the national research or extension service that carries out an FSR/E agenda as an isolated part of the national research or extension program;
- an FSR/E program with a regional focus in which a geographic section of the country comes under an FSR/E orientation;
- a thorough integration of FSR/E as the major orienting principle of research and extension activities.

This distinction between different types of FSR/E integration is critical because the specific structural relationship is a strong indicator of the likelihood that the FSR/E program will continue beyond the life of individual donor-funded projects.

Asia. The agricultural research in most Asian countries has been organized around a well-defined commodity focus, reflecting in part the impact of Green Revolution successes. For example, in Indonesia the commodity-focused structure of agricultural research is strong, and FSR/E activities have been located primarily in the food crops institute (McArthur and Rerkasem, 1988). Alternative strategies for the structural organization of FSR/E activities have been followed in Nepal and the Philippines. In Nepal, the government created a separate division of farming systems research and a division of socioeconomic studies and extension. In the Philippines, regionally focused FSR/E activities have been promoted (e.g., East Visayas Project).

Latin America. As in Asia, Latin American countries have followed a diversity of organizational structures in their integration of FSR/E approaches. In Guatemala, the FSR/E orientation pervades the total national agricultural research program through efforts pioneered by the Instituto de Ciencia Tecnologia Agricolas (ICTA) (DeWalt and Hudgens, 1988). In Honduras, project-focused FSR/E activities have made it difficult to integrate the approach effectively into the national agricultural research system. Similar problems have been encountered by the Centro Agronomico Tropical de Investigation y Ensenanza (CATIE) in the regional FSR/E activities. In Brazil, tie FSR/E philosophy has been compartmentalized into a specific minor division of EMBRAPA rather than integrated throughout the research system.

Africa. In many of the African countries reviewed, FSR/E has been integrated into the national research bureaucracy. By the mid-1980s, nine African countries had reorganized to accommodate FSR/E (Baker and Norman, 1988). The organizational structure of the integration has taken many forms. For example, in Zambia, Malawi and Senegal the FSR/E teams are well integrated into the national agricultural research systems. In Botswana, FSR/E efforts are evolving out of a project mode into the Department of Agricultural Research (Frankenberger and Mitawa, 1988). In Zaire, FSR/E activities are still primarily carried out under the auspices of donor-funded projects (e.g., the Zaire Agricultural Productivity Project).

Cost Sharing in the FSR/E Program

Another indicator of the degree of institutionalization of the FSR/E approach is extent of budgetary support the national bureaucracy allocates to the FSR/E program. In most LDCs, the bulk of national research and extension programmatic efforts are financed by outside donor agencies. National budgets cover staff salaries and some operational funds, but major projects must depend on other funding sources. In view of the scarcity of domestic resources, the use of national funds to support FSR/E activities relative to other research and extension programs indicates a strong commitment to small-farm agriculture. FSR/E programs composed totally of donor-funded projects show a lesser degree of institutionalization relative to those in which the national government assumes responsibility for the recurrent operational and training costs of the FSR/E program.

Asia. In all the countries reviewed for the Asian region, the major projects of the FSR/E program are funded by outside donors. The national agricultural research organizations usually pay the salaries of their researchers (the Philippines, Nepal, Indonesia), but the bulk of the operational costs and capital items are covered by donor funds. The Asian examples suggest that governments are ready to allocate their available resources such as manpower toward FSR/E activities but that programmatic funds are scarce for any set of research activities.

Latin America. In Latin America, similar problems regarding operational support are widespread. National research organizations can contribute manpower to FSR/E projects, but donor funding of programmatic expenses is needed. Guatemala is one of the few countries that contributes substantially to the operational budgets of its national agricultural research organization (i.e., ICTA).

Africa. As in Asia and Latin America, African countries continue to have problems providing operational support to their FSR/E activities. Donors continue to fund most of the programmatic expenses while national agricultural research organizations provide the manpower (i.e., Zambia, Senegal). Funding for agricultural research in Africa has received low priority in many countries, making it difficult to compete for scarce funds.

Commonality of Approach

The FSR/E methodology is evolving in both its concepts and its applications in practice. Many conceptual nuances have been subsumed under the "farming systems approach" banner that may differ greatly in strategies of action (Merrill-Sands, 1985). In any given country, several FSR/E projects-funded by several different donor agencies-may be carried out simultaneously within a single national research or extension organization. The effective coordination of these projects under a single FSR/E philosophy and definition is a positive indicator of institutionalization. Adversely, if each project adopts its own version of the farming systems approach, confusion is quite likely, and the probability of long-term impact may be diminished.

Asia. Conceptual consistency within the FSR/E program is related to the structural organizational theme. In countries where FSR/E approaches are integrated primarily into existing commodity programs, heavy emphasis is given to adaptive research and on-farm testing (e.g., Indonesia). In countries where FSR/E activities have a regional focus, more emphasis may be given to multidisciplinary, resource-based approaches (e.g., the Philippines). Some countries employ both approaches (e.g., Indonesia).

Latin America. In Guatemala, ICTA has maintained a constant and consistent conceptual model for its research activities, emphasizing multidisciplinary teams, adaptive research and farmer participation (DeWalt and Hudgens, 1988). In CATIE, however, the term FSR/E is not readily embraced by the staff, which prefers to regard its own methodology as unique. Although several types of systems-oriented, adaptive research are found in Latin America, most of these variations share the basic criteria of the FSR/E methodology.

Africa. A multitude of FSR/E approaches have been implemented in Africa due to donor biases, the institutional mandate followed by the International Agricultural Research Centers that are promoting FSR/E (e.g., CIMMYT, IITA, ICRISAT), the placement of donor-funded projects under different administrative umbrellas (e.g., research vs. extension) and the availability of trained researchers (e.g., social scientists). For example, in Botswana, four farming systems projects funded by four different donors were not following the same approach. Efforts are currently being made to coordinate these efforts under a single FSR/E philosophy.

Differential Components Application of the FSR/E Approach

As stated earlier, the FSR/E methodology is comprised of identifiable components, or stages, each of which is necessary to the successful application of the approach. The imperfect integration of FSR/E into national agricultural research systems may result in placing an undue emphasis on an individual component of the total process. When institutional linkages are weak, it is quite easy to view FSR/E as primarily doing diagnostic surveys or implementing on-farm trials. For example, an institution can have a strong multidisciplinary diagnostic group that gathers increasing quantities of farm-level information that remains essentially unanalyzed and provides little input into succeeding stages of research. Associated with this theme is the tendency to divide the different FSR/E functions by discipline. Thus, the social scientists come in to do the diagnostic phase, the technical scientists conduct the on-farm research and the extensionists disseminate the new technology. The full potential of multidisciplinary interaction is not achieved in this situation, and the systems approach of the methodology is lost.

Asia. When an FSR/E project resides within a commodity division of the national agricultural research organization (e.g., Indonesia), the on-farm testing component of the FSR/E approach is likely to be emphasized. Projects that are regionally focused or are located in cross-disciplinary divisions of the research bureaucracy tend to be more equally balanced across the different FSR/E components (e.g., Nepal and the Philippines).

Latin America. In the Latin America countries reviewed in this study, the diagnostic component of FSR/E has received heavy emphasis. For example, in Guatemala, the amount of field data collected by ICTA on the farming systems far surpasses the analytical capacity of the staff.

Africa. In the early years of FSR/E implementation in Africa, heavy emphasis was placed on describing the farming systems in place (e.g., Nigeria, Mali and Senegal). This bias was probably due to a combination of factors, such as the lack of information that existed for project target areas and the limited number of appropriate interventions available for these harsh production environments. Presently, the emphasis is shifting, with greater emphasis being placed on the testing stage and extension (e.g., Botswana) (Baker and Norman, 1988).

Short-Term and Long-Term Training

Training of national agricultural research personnel is a critical element and important indicator of the degree of adoption of the FSR/E methodology. The lack of adequately trained personnel can be the greatest potential constraint to FSR/E institutionalization. The impact of training on national organizations and their ability to adopt the FSR/E methodology depends upon both quantitative and qualitative factors. Maintaining a critical mass of human capital trained in FSR/E techniques assures that the methodology is properly implemented and forms an integral part of the planning process. A proper balance in training is also needed among the different levels of the bureaucracy to ensure program continuity. The ability to retain highly trained individuals is also a strong indicator of the strength of the program.

In general, long- and short-term training of professional staff has been one of the most visible and effective impacts of the worldwide investment in FSR/E programs. The support of both degree training and short-courses by USAID, the regional farming systems networks and the IARCs have helped strengthen systematic approaches to agricultural research.

Asia. In all of the Asian countries reviewed for this synthesis, a portion of the national research staff had received either degree training in a particular discipline or had attended short-courses that provided training in the FSR/E methodology. The regional Asian Farming Systems Network and IRRI were particularly active in either offering or sponsoring training for FSR/E practitioners.

Latin America. Training also has been an important contribution of FSR/E programs in Latin America. CATIE provides both degree training and short-courses in systems methodology and adaptive research. ICTA in Guatemala introduces all incoming staff members to an intensive orientation to the FSR/E philosophy and techniques. Opportunities for degree training through FSR/E projects have attracted high-quality staff members. However, retention of trained staff within the FSR/E projects has been problematic throughout Latin America (e.g., Guatemala, Honduras, Panama).

Africa. As in other regions, training has been a very important aspect of FSR/E projects implemented in Africa. Degree training and short courses have been an essential ingredient of USAID-funded projects as well as some other donor projects, and the IARCs, like IITA, CIMMYT and ICRISAT, have been quite active in providing training to FSR/E practitioners. Retention of trained manpower has also been difficult for FSR/E programs (e.g., Botswana, Senegal). This is due to the fact that national research organizations often have to fill other posts with trained personnel due to manpower shortages and because trained staff are not keen on living in rural areas where access to faculties, services and opportunities for career advancement are limited.

Institutional and International Linkages

Another dimension of institutionalization is the creation of regular institutional ties among different units of the national agricultural research system. At one level, institutional linkages should be established between the FSR/E components and the commodity-focused research component. The FSR/E methodology clearly emphasizes the interdependence and complementariness of on-station research and on-farm research. However, in practice, the linkages between the two are not easily established.

Another important linkage must exist between research and extension if FSR/E programs are to be successful. In many countries, these two units within the Ministry of Agriculture compete for the same scarce resources. In most cases research and extension are physically isolated units within the Ministry.

The FSR/E theoretical focus on the system of interrelated farm activities requires a similar systemic approach to problem-solving at the institutional level. Multi-stranded linkages between researchers and extensionists, among the specialty disciplines and between social and technical scientists are necessary components of the institutionalization of FSR/E. Consequently, the presence or absence of these linkages serves as illuminating indicators of the degree to which the approach has been incorporated into the national research and extension system.

The theme of linkages also can be approached from a perspective of expanding international networks. The practical application of the FSR/E methodology has exposed national agricultural research and extension services to the international flow of ideas in both the public and private sector. Regional farming system networks and the system of international agricultural research centers provide regular input on technology development as well as information on FSR/E projects in other countries. The degree of integration into these networks can reflect the level of institutionalization of the FSR/E methodology.

Asia. Intra-institutional research linkages have varied in the Asian case studies. In Indonesia such linkages appear to be strong whereas in Nepal, Bangledash and the Philippines these ties have been difficult to establish. The inter-institutional linkages between research and extension have been effective in most of the FSR/E Asian programs. This is especially true in regionally focused FSR/E projects where staff members are seconded from their home institutional units to work in teams at regional locations. Such regional programs have also promoted effective interdisciplinary research activities. International collaboration has been strengthened through the efforts of the Asian Farming Systems Network. Similarly, IRRI's involvement in adaptive research and training has provided a rich resource for inter-communication among FSR/E practitioners.

Latin America. Intra-institutional linkages between on-farm and on-station research have been strength ened within the context of FSR/E projects, but such ties have not become formalized elements of the research process for many programs. In Guatemala ICTA has not been totally effective in getting farmers' problems translated into on-station research priorities. In Honduras, Ecuador and Panama, there is no formal integration between commodity researchers and on-farm researchers, although commodity researchers are more aware of the value of on-farm research. As for inter-institutional linkages, the integration of research and extension is the most difficult to formalize. The tendency has been for FSR/E researchers to perform what is effectively an extension role. Interdisciplinary collaboration between social and technical scientists has been strengthened by FSR/E programs. However, social scientists are only minimally involved in the technology validation teams (DeWalt and Hudgens, 1988). International linkages have been strengthened through the efforts of organizations such as CIMMYT, CIAT, CATIE and the USAID-funded Farming Systems Support Project.

Africa. Intra-institutional relationships between on-farm and on-station research have been strengthened by FSR/E activities in some countries, but full integration has not been achieved. Reasons for this include 1) the view that FSR/E work competes for limited funds and resources that would otherwise be available to commodity-focused research; 2) the desire of donor-funded projects for quick results, which is inconsistent with ongoing research programs conducted on-station; and 3) the reluctance of on-station researchers to fully accept farmer assessments of technology as adequate justification for technology recommendations. Research and extension integration has also been difficult to achieve in most African countries. Interdisciplinary collaboration has been good where adequately trained personnel are available. Social scientists are in short supply for many programs. International linkages have been enhanced by the IARCs (ITTA, CIMMYT, ICRISAT) and other regional networks such as the West African Farming Systems Network and the Southern African Development Coordinating Council.

Farmer Participation

The nature of farmer contacts reveals an important dimension of the success of a given FSR/E program. The ability or willingness of researchers and extensionists to develop and maintain steady interaction with small and resource-poor farmers has generally been a problematic issue. In addition, research designs for on-farm experiments may not fully integrate farmers, especially if they are devised centrally. Farmers may not be included in the planning of on-farm trials or in the evaluation of the results. In this respect, farmer participation is an important measure of the true FSR/E integration into national agricultural research programs.

Asia. Farmer participation in the planning of on-farm experiments and the evaluation of alternative technologies has been mixed. Regional FSR/E projects have been designed to incorporate this input, but they have not been totally successful in this regard (e.g., Philippines).

Latin America. In Guatemala, farmer participation has been a core feature of ICTA's philosophy. However, CATIE has been criticized for the poor quality of interaction with local farmers in their on-farm trials. As elsewhere, effective incorporation of farmers into all the FSR/E process often requires the bridging of serious class and social status constraints.

Africa. Farmer participation in the FSR/E process has recently become very important to projects and programs in Africa. In the early 1980s, most FSR/E projects focused on evaluating the technical feasibility and economic viability of production practices and varieties (Baker and Norman, 1988). Currently, farmers are playing a greater role. For example, in Botswana farmer participation in FSR/E activities has been facilitated by the promotion of farmer groups for testing technologies (Norman et al., 1988).

Information Dissemination and Public Policy

The FSR/E methodology is information-intensive. In many countries, the diagnostic stage provides an unprecedented wealth of knowledge about the composition and the variability of rural society. At regional and national levels, policymakers are involved in the ongoing task of directing agricultural policy toward national goals. The information feedback from the FSR/E approach usually gives these policymakers a better ability to foresee who benefits and who loses from a given policy set. Target populations ("recommendation domains") are discerned more clearly in terms of their particular problems and respective access to resources. How effectively FSR/E-generated information is channeled to and used at policymaking levels is a further indication of institutionalization.

The importance of information dissemination cannot be underestimated. An important objective of farmer oriented, on-farm research is to promote communication in both directions so that resource-poor farmers become more aware of the wider context of which they are a part. The systems focus of the FSR/E methodology implies that technology innovation is also a function of such factors as pricing policies, input distribution and marketing infrastructure; knowledge of these relationships helps farmers to make more effective decisions.

Asia. FSR/E approaches have increased farmer awareness of their sociocultural environment, and farmers have gained access to more technical and economic information (e.g., Indonesia, Nepal, the Philippines). However, none of the case studies indicated that information from the FSR/E diagnostic studies was being used by policymakers.

Latin America. As in Asia, there was no evidence in the cases reviewed for Latin America that government decision makers are utilizing FSR/E information in policy formation. Policy decisions in Latin America in general have tended to favor larger farmer interests and strong political groups. FSR/E activities have improved information flow to farmers in many of the countries.

Africa. As with the other two regions, FSR/E activities in Africa have not had a significant impact on policy formulation. Policy decisions have tended to be based on political interests that do not encompass small-farm

development (Collinson, 1988). FSR/E projects have also used the wrong format to present research findings to policymakers (e.g., Botswana). However, information transfer to farmers has been an important result of FSR/E activities in Africa. Such information has enhanced farmer confidence in research, stimulated farmer initiated activities and influenced farmers' demand for technology (Molutsi et al., 1988).

Impacts of Technology Transfer

The long-run impacts of institutionalization of the FSR/E methodology are assumed to be welfare increases for small-farmer households and possible increases in national production. These impacts—as stated above-are seldom measurable in the earlier stages of FSR/E programs; the benefits of FSR/E efforts are gradually rather than discreetly realized. In some countries-for example, those with ten years experience or so-the local impacts begin to be manifested. One measurable impact is the spread of technological alternatives. Superior crop varieties or specific technological "packages" may have appeared as a result of FSR/E projects; they are in the process of being disseminated and adapted to further regions. National production figures on given commodities or on the structure of production may indirectly point to the benefits of FSR/E gradually spreading throughout rural society. The absence of such indicators in countries of briefer FSR/E experience should not be interpreted pessimistically.

Asia. It is clear that throughout Asia, FSR/E activities have produced several technological alternatives, especially those that involve variety use and an intensification of purchased inputs. It is impossible to isolate the influence of FSR/E efforts in the process of technology transfer, but this review indicates that positive impacts have been brought about in Indonesia, the Philippines and Nepal.

Latin America. There has been ample documentation that the FSR/E approach in Guatemala has generated technological alternatives involving more productive crop rotations, improved seed varieties and different input packages. CATIE has also promoted technology transfer in the area. However, these technologies have not always reached the small-farm sector as thoroughly as desired.

Africa. One of the main limitations for FSR/E projects with regard to technology transfer in Africa has been access to good on-shelf technologies. Although successes have been documented (e.g., Gambia and Tanzania), the environmental constraints have often limited research payoffs in the short run (e.g., Botswana).

SUMMARY OF IMPACTS

This review of select FSR/E programs in different regions of the world suggests that the FSR/E methodology is an appropriate and effective mechanism to channel resources to the small-farm sector. The success of the program, however, is a function of two critical elements, both of which can be somewhat influenced by external funding and donor support. The first is time. Technical change and improvements in small-farmer welfare will follow from the institutionalization of FSR/E methods into national research bureaucracies. This process of institutionalization is gradual and time-consuming because it requires quite a revolutionary change in how bureaucracies define problems in their national agriculture as well as how they frame solutions.

The second element is investment in human capital. Training has made the most significant impact on the institutionalization of FSR/E, and it is the component of the program that is most cost-effective. Both degree training and orientation short-courses are essential to sustain FSR/E efforts in national research organizations. With this investment in human capital bolstered by a dynamic and vibrant international network of practitioners, the positive impacts of the FSR/E methodology will continue.

CONSTRAINTS TO FSR/E PROJECT/PROGRAM IMPLEMENTATION

Overall, the major constraints to FSR/E program implementation across countries were 1) competition with other institutions in the research organization and 2) weak links between research and extension. For Africa, the major constraints were 1) competition with other institutions; 2) the environment; 3) access to trained manpower; 4) staffing of field teams; 5) cost of technology and access to inputs; 6) poor linkages with policymakers; 7) weak links with research and extension; 8) on-farm experience of research staff; and 9) the role of extension. For Latin America, the major constraints were 1) competition across institutions; 2) weak links between research and extension; 3) budget constraints; 4) cost of technology and access to inputs; 5) poor linkages with policymakers; and 6) agricultural prices and marketing. For Southeast Asia, the major constraints were 1) weak links between research and extension; 2) project design; 3) design of on-farm trials; and 4) involvement of farmers in the research process.

LESSONS LEARNED

A number of important lessons can be drawn from this review. These are listed below.

1. The lack of cooperation between research and extension is common in national agricultural research and extension systems. FSR/E can play an important bridging role between extension and agricultural research. FSR/E teams test technology from research and provide researchers with feedback from farmers and extension to help set research priorities. Technologies are not always directly transferable from research to extension.
2. All FSR/E projects within a country should be placed under one administrative umbrella. Placing FSR/E programs under research rather than extension may be the preferred mode. FSR/E teams placed under research divisions have better access to research results and can influence priorities more easily than those placed under extension. Linkages with extension are more likely to develop due to the location of FSR/E teams in the field.
3. As research programs decentralize, FSR/E teams could form the core of regional research teams working in different ecological zones.
4. Unless incentives are provided, it will be difficult to retain trained manpower in the Geld as long as career advancement is contingent on placement in a centralized research organization. Consequently, there is also little professional reward for interdisciplinary and inter-institutional collaboration. Despite this, human capital development is essential to the success of viable FSR/E programs.
5. The reluctance of commodity-focused researchers to test and disseminate technologies and practices on farmers' fields until final solutions are reached is limiting potential production improvements unnecessarily. There is a need to test best-bet alternatives so that farmers can participate in the assessments.
6. FSR/E activities carried out on a project basis independent of on-station research programs are usually not conducive to long-term research. This leads to a failure to develop credibility among planners, on-station researchers and extension agents. In addition, the scale of projects may be the biggest barrier to national sustainability of externally funded development initiatives. Thus, serious consideration should be given to initiating FSR/E activities in a project mode.
7. Impact on agricultural policy is one area in which FSR/E programs have not fulfilled their potential. The way results are presented is often the key. An honest assessment must be made as to what extension can use, what research can use and what policymakers will read. Executive summaries that highlight major points could have significant impacts, especially if the information is packaged appropriately to address policy issues.
8. A well-prepared plan or strategy that outlines the process of technology assessment could help improve the linkages between commodity-focused researchers, FSR/E teams and extension. Such a plan would specify disciplinary responsibilities, methodological stages and feedback channels. This plan could then be used to orient new researchers who come into the research or extension program.
9. One of the main limitations for FSR/E has been access to good on-shelf technologies for immediate agro-ecological adaptation. This is especially true for marginal areas under harsh conditions, often where FSR/E teams are assigned to work. Under such conditions, research payoffs are often limited in the short run and may take considerable time to develop. FSR/E programs have always been more successful in more favorable environments. In harsh climates, fewer successful interventions are available, and it is often necessary to substantially modify the existing farming system. Thus, it is inappropriate to assume that viable results can be achieved in the same time frame for both types of environments. Such comparisons may have led to the impression that FSR/E approaches have not lived up to expectations (Baker and Norman, 1988).
10. A major difference between on-station testing of technology and on-farm testing is the value placed on cause-and-effect relationships. On-station trials focus on such relationships, whereas on-farm trials are less controlled. Farmer assessments play a key role in such trials, which are not necessarily considered valid to on-station researchers. This can influence the speed at which research recommendations are passed on to extension. In addition, the need of some researchers to determine cause-and-effect relationships in on-farm trials has influenced the emphasis placed on farmer-managed technology validation.
11. Successful FSR/E programs tend to have sufficient capital for operating expenses. An appropriate ratio of expenditures for staff and operations will ensure that on-farm testing is feasible. Expenditures of 90% of the budget for salaries will significantly limit research opportunities.

12. Expatriate technical assistants should be directly incorporated into the structure of the research organization and extension system. They should not be placed in richly endowed projects that have little resemblance to the working realities of national scientists and extension workers. Attempts should be made to work within the existing resource base.
13. Past experience with systems research can facilitate the successful integration of FSR/E programs into the national agricultural system.
14. Farmer participation in bottom-up planning and research is difficult to achieve within a research system that-requires that lines of authority and responsibility be clearly defined by the central office. Adapting a flexible and dynamic bottom-up development process to a highly centralized and vertically structured research organization is a difficult task. In the same way that farmers select and modify technologies to fit the particular farming system and resource base, governments are attempting to adjust and incorporate the FSR/E process within the national agricultural structure (McArthur and Rerkasem, 1988).
15. Projects that focus on short-term technology generation and/or production objectives may impede rather than reinforce the long-term goal of integrating the concept and methods of the FSR/E process into the national agricultural system (McArthur and Rerkasem, 1988).
16. Networking is a key activity for overcoming methodological stagnation. The training aspects of meetings are extremely valuable.
17. Many FSR/E projects/programs have not effectively used social science input. Despite the importance of characterization of areas, anticipating sociocultural problems and the need for baseline studies to be used as comparisons for evaluations, very few social scientists are brought into FSR/E programs. This is due both to a shortage of trained personnel and to perceptions of social scientists on the part of technical scientists. Consideration should be given to how social science input can be useful to ongoing research activities after the diagnostic phase.
18. In spite of the fact that support for FSR/E programs has increased among national planners in low-income countries during the 1980s, USAID and other donors began shifting their emphasis away from farming systems research. This declining support dramatically reduced the pace of FSR/E institutionalization after 1985 (Baker and Norman, 1988). Despite such reductions, numerous countries around the world have reorganized their national research organizations to accommodate FSR/E. Regional networks, such as the Asian Farming Systems Network and the West African Farming Systems Network, have been established to allow scientists to share experiences and learn new ideas. In addition, more than 10 universities in the United States have established programs focused on American agriculture (Baker and Norman, 1988). In light of these developments, USAID played a significant role in establishing FSR/E programs around the world. As a development agency responsible for its past initiatives, backstopping the FSR/E programs in the form of support for training and networking is a necessary obligation.

POSSIBLE TRENDS

Baker and Norman (1988) have outlined a number of directions in which the FSR/E approach has evolved and speculate on future directions. These include the following:

1. A narrowly focused FSR/E approach that was developed at the IARCs has given rise to a more comprehensive, longer-horizon systems approach.
2. Farmer participation in FSR/E activities has increased through time.
3. The domination of FSR/E programs by donor agencies and expatriate technical assistance has given way to localized programs.
4. There is declining interest in describing farming systems and increasing interest in pushing technologies through the testing stage and extension.
5. The evolution of FSR/E has been heavily influenced by the expanding number of academic professionals representing several disciplines. These academics have shown interest in expanding the focus of FSR/E and have placed emphasis on farmer-first perspectives.
6. Bureaucrats in donor agencies and National Agricultural Ministers are questioning the viability and affordability of decentralized, bottom-up approaches to development. They would like to see the emphasis shift to commodity-focused programs that address national planning goals in high payoff environments.

CONCLUSION

In most developing countries, the national agricultural research and extension service is heavily dependent on donor-funding sources. Domestic budget funds are expended in salaries and some operations, but any investment in research and extension is often tied to the specific projects financed by outside donors. Almost without exception, this bilateral or multilateral financing is tied to a specific development strategy or concept. This situation ties the national agricultural research and extension structure to the current trend in research and development. Seldom are national structures able to apply outside funding to their existing program of research and extension. This fact bodes poorly for the future of FSR/E in terms of continued support. The sustainability of the advances made through the range of FSR/E programs will be insured only if sustaining investment is made. National agricultural bureaucracies must have a place to solicit assistance in upholding the vitality of their FSR/E programs. Spot investment in training and in maintaining international linkages is a possible strategy that might be coordinated among the various funding sources.

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THE CONTRIBUTION OF PAKHRIBAS AGRICULTURAL CENTER TO THE DEVELOPMENT OF FARMING SYSTEMS IN THE EASTERN HILLS OF NEPAL

Ramesh Khadka and David Gibbon[1]

INTRODUCTION

The Pakhribas Agricultural Center (PAC) was established in 1973 with the objective of making the poor farmers of its target area self-sufficient in food and other needs through a multidisciplinary approach to agricultural development. The center is located in the Eastern hill region on Nepal (Fig. 1). An autonomous project, funded by the British Government's, Overseas Development Administration (ODA), it has been a constituent of the Koshi Hills Development Project since October 1987.

PAC provides services to the Eastern hills of Nepal and in particular the four hill districts of Koshi zone (namely Dhankuta, Terhathum, Sankhuwasabha and Bhojpur), an area of 7,000 km^2 with about 100,000 farm families.

The Eastern hill region extends from the Terai (300 m) to the Himalayas (Makalu >8000 m). The terrain is composed of steep terraced hillsides cut by many streams and rivers with very little flat land, which is developed mostly in the river terraces. The climate varies from hot, dry, and subtropical in the river valleys to cool, moist, temperate in the high hills. Mean annual rainfall varies from about 800 mm to 2000 mm, with about 70% of the annual precipitation occurring between June and September (Monsoon). Soils are mostly micaceous and acidic in nature. Four distinct seasons, winter, pre-monsoon, monsoon and post-monsoon are recognized.

Farming Systems

The region contains many diverse farming systems, most of which are semi-subsistence in nature. They change both within and across physical environments (Fig. 2) depending on the resources available to the farmers and the needs of the family. In the High Himal (around 4500 m), summer grazing of yak is practiced where the Tundra vegetation with open meadows occurs towards the lower elevations while in the high mountain region (2300 - 4500 m), winter and summer grazing of the yak, forest grazing and sporadic, unreliable cropping occurs. Towards the lower elevations of the high mountains, livestock-based farming systems are practiced where the sub-alpine climate with Betula Abies forest vegetation exists. In the high altitude hill (1700 - 2300 m), the main staple crop is potato, which is frequently interplanted with maize. Barley and buckwheat are the other important crops of this area. The climate is cool temperate with Quercus forests.

In the mid-hill (1100 - 1700 m) region, a maize/finger millet-based pattern predominates. Farmers keep a wide range of livestock (cattle, pigs, buffalo, chickens). While rice-based cropping patterns are practiced in the mid-hill region, rice predominates at the low altitudes (<1100 m), khet (bunded contour terrace land) under rainfed conditions and with irrigation. In these low altitude khet lands under irrigated conditions, the cropping intensity is very high with a rice-rice-wheat pattern that sometimes reaches 300% (Willett, 1984). Many grain legumes (beans, soybeans, cowpea, blackgram) are interplanted with maize in the bari (unirrigated contour terrace), and many of these legumes are also planted on the bund of paddy terraces. Mustard is grown for its edible oil. Various vegetables such as cucurbits, aubergines, chili, cauliflower, cabbage, radish and broadleaf mustard are grown. Also found are both temperate fruits (pear, peach, plum and apple) in the high hills and subtropical fruits (citrus, mango, banana, guava, papaya) at the low altitude. Cash crops include cardamom, tobacco and groundnut. Tea is grown for home consumption. Ginger, garlic, chili and many other species are cultivated.

Livestock is an essential and integral part of farming systems. Cattle provide the main form of draft power, and manure is provided by all classes of livestock. The sale of animals and animal by-products is extremely important for small farmers who derive 55% of their farm income from livestock (Conlin and Falk, 1979). Crop by-products are utilized for animal feed. Recycling of the by-products is thus essential to maintain the integrated farming systems.

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Diverse forests occur in this region and not only protect the soil from erosion but also provide the much-needed fodder for animals, compost materials and firewood for household use. Crop and livestock production rely substantially on resources from trees and forests (Khadka, 1987). The direct interactions involve those between trees and field crops (soil conservation, shading by trees on crops), fodder trees and animals, cattle manure and crops (Fig. 3).

Land holdings are very small and fragmented with 43% of the farm families having less than 0.5 ha of land (Table 1). Moreover, the small farmers usually have access to more bariland, which is less productive than khetland. A single farmer's production system is rarely carried out on just one contiguous piece of land; rather, he may farm four to five pieces that may be scattered across more than one agroecological zone. This makes management difficult but also provides farming families with their diverse requirements and spreads risk.

COMPONENTS AT PAC

Pakhribas Agricultural Center (PAC) currently provides technical help to farmers of the area through its nine technical sections. The Agronomy Section deals with all aspect of research on important field crops of this area, with the objective of developing, screening, selecting and recommending crop varieties and husbandry practices suited to the Eastern hills. This section was the first in the region to adopt the crop research methodology that involved both on-station and on-farm components, which has been taken as a model by other agencies.

The Animal Production Section has developed and extended a black-colored pig that does not get sunburnt and is preferred by particular groups of farmers for religious purposes. The pig has been very popular and now comprises 70% of the total pig population. The Forestry Section focuses on research (silviculture and nursery), production and extension backup support.

The Training Section conducts training on agriculture, livestock and forestry for farmers, PAC staff and staff from other agencies in the region. Training is conducted both at the center and in the field, and different types of training are provided pre-service (a multidisciplinary training to field staff before entering the service) and in-service (twice a year to upgrade the knowledge of the staff) as well as leader-farmer training of three days to one month duration.

Cultivar maintenance and breeder/foundation seed production, seed research, seed storage and processing and quality control are the major activities of Seed Technology Section. The Horticulture Section conducts a series of research programs on fruits and vegetables and produces seedlings. The Extension Section conducts demonstration, training and extension research, supplies inputs and disseminates the technologies for the benefit of the farming communities. Currently, the adoption rate of improved maize is 65% of the total maize growing area and 6% for the improved rice variety. In the low-altitude Khetland wheat-growing area, almost all wheat grown is of improved varieties. In the target area near PAC, the estimated production increase due to improved varieties is 50% over the last 10 years, which is estimated to have given a 25% increase in income per family.

The Veterinary Investigation and Analytical Services Section assists the Livestock Section. Identifying diseases of animals, studying their epidemiology and development and evaluating control measures are its main activities. The Socio-economics Section advises and manages survey and monitoring and evaluation work of the center and provides the socio-economic input to the work of the other technical sections. It has completed a series of surveys on vegetable market identification and adaptation of improved maize and farming system studies. It is also involved in the collection and analysis of data for agroecological and recommendation domain zoning and participates in regular joint trek activities.

ON-FARM RESEARCH AT PAC

On-farm research was initiated, planned, designed and implemented by the Agronomy Section in 1983 with the objective of producing recommendations of improved crop technologies that were of immediate relevance to the majority of the farmers in the target area (Green et al., 1985). To implement on-farm research (OFR), PAC worked with Koshi Hill Area Rural development Project (KHARDEP), a British aid-funded integrated rural development project, which had established three Agricultural Services Centers (ASC) in each of the four districts (target area). Each ASC has a command area of four to seven Panchayats (the local administrative unit), and one representative panchayat was selected in one ASC where the site description survey was conducted using secondary data and key informant fanners. This provided the background information on resources, infrastructure, institutions and the predominant cropping patterns; these cropping patterns were then

selected for on-farm verification trials. In 1985, this concept of recommendation domains was adopted, and now OFR trails are designed for three altitudes (high, medium and low) and three land types (upland, lowland irrigated and lowland rainfed).

Trial methodology (Fig. 4) includes the implementation of researcher-managed farmers' field trials (FFTs) to generate provisional recommendations to be verified further in diamond trials and as the minikits (packets of near-recommended varieties with or without inputs). Recently, informal research and development activities have been included in the programs.

The OFR at PAC is managed by a team of district-based outreach staff. The district team consists of one agronomist, one junior technician (JT) and three junior technical assistants (JTA) for each district. The district agronomists are based in the district Agriculture Development Offices (ADO) in each in the four districts and spend 60% of their time in the field (Table 2), managing the on-farm trials. The JTs act as the link between the agronomists and the JTAs, and they spend 80% of their time in the field. The JTAs, who are locally hired, are based at each of the OFR sites and are responsible for selection and daily management of the trials.

The annual program planning of OFR is carried out by a joint meeting between on-station research (OSR) staff and OFR staff. The program is further discussed with the Extension and Seed Technology sections, and finally it is presented to representatives of all sections during the trial protocol meeting. The provisional program is also circulated to the district agricultural officers for comments and agreement, especially on the joint program. New technologies available from the previous year's OSR results and the problems faced by the farmers in the field are considered for the research program. OFR is also based on farmers' problems and priorities, which are identified during the Samuhik Bharman.

Each month the JTAs send a monthly report to the center/district on the trial activities and also submit a monthly work plan. The JTs and agronomists report frequently to the center on who goes on tour. These tour reports and the JTAs' monthly progress reports are very helpful both for monitoring and for evaluation of the OFR. Both agronomic and economic analyses of the trials are performed. Farmers' comments and views on the OFR are highly valued. As far as is possible, the section staff ensures that the technologies recommended are technically feasible, economically viable, institutionally sustainable and socially acceptable to farmers' conditions. The seasonal reports are presented in national seminars in which the information is widely circulated to all OFR practitioners under coordination of a senior agronomist from the center. Administration and technical guidance is provided by the chief agronomist. Of the sectional budget, about 60% is allocated for the OFR research and the rest for OSR.

CHANGES IN RESPONSE TO FARMERS' NEEDS: SOME EXAMPLES

Organizational Change

Since its inception, PAC has constantly undergone a dynamic process of change and has evolved as a multidisciplinary center. It now provides a service to the diverse needs of farmers who are involved in complex farming activities. Originally in 1973, PAC was established as a small project to provide training to the retired personnel from the Gurkha Regiment of the British Army. In 1975, it was expanded to cover an area with over 9000 farm families, and crop extension, livestock, horticulture and engineering sections were established. Production of animals and plants was also started. On-station research supported the extension and training activities. By the year 1982, PAC started working as a multidisciplinary center with all aspects of agricultural development, including livestock and forestry. Both on-station and on-farm research supported the extension activities and inputs supply (seed, fertilizer, animals) and training to farmers were well coordinated. PAC also expanded its area to cover 7000 km^2 with over 100,000 farm families under the KHARDEP. By 1990, the center has a mandate to cover 11 districts in the Eastern hills, about 12% of the country (NARSC, 1988).

Inclusion of Women in the Extension Program

It was realized in 1986 that women farmers did not fully participate in the PAC extension and training programs. To help these women farmers, a special women's development program was launched two years ago, with a women's development officer and some locally employed women motivators. A vegetable kitchen garden project has been promoted through this program. Although the kitchen gardening was introduced in 1980, it met with little success. The extension workers realized later that vegetable growing for home consumption and for the local market was performed by the women. Since then, the promotion of the garden project through the women motivators has achieved a tremendous success (Table 3). This program is now being expanded to cover other key farm activities in which women are actively involved. These include seed selection and storage, fruit and vegetable preservation, use of improved smokeless stoves and rabbit keeping.

Exploring Local Resources

Frequently, the curiosity of farmers to try out new technologies has led to misunderstandings by researcher. For example, the Livestock Section initially was heavily involved in production and distribution of an improved goat (Jamunapari) that looked very attractive and was very much in demand. Very little research had been carried out on its adaptability, and with experience it proved to be unsuitable for most of the area. This program has now been stopped, and research has been started to evaluate the well-adapted local breeds. The Forestry Program has also switched from supplying seedlings of exotic species. The Crop Research Program has made provision for exploring local germplasm for tolerance to diseases, pests and low soil fertility. Experience has shown that local varieties, e.g. Pokgreli masino (rice) and Lumle-1 (soybean), have been found superior to many exotic varieties (Chand, 1987). This change in emphasis from exotic to the local resources has been largely influenced by the researchers' knowledge of the farmers' technologies and situation, which has been gained through a long period of interaction with them.

Farmers' Participation in the Breeding Program

In Nepal, the breeding of crop varieties and the subsequent selections up to an advanced stage are carried out in the lowland plains (Biggs, 1988). Since the agroclimatic conditions are different between hills and plains (Terai) and since little knowledge of the hills and farmers' practices and preferences exists in these breeding centers, most of the crop varieties recommended for the hills fail. For example, the maize varieties recommended for the hills were yellow seeded, but the farmers preferred the white-seeded ones. PAC, in cooperation with the National Maize Development Program, developed a white maize (Manakamana-1) that has proved a tremendous success. This led PAC to start its own crop breeding program in the major crops for the area. In these programs the breeders are helped with feedback from the laborers and junior staff at PAC who come from the area and are essentially local farmers. This system has been very effective.

Focus on the Resource-Poor Farmers

Originally, and for many years, PAC's policy has been to utilize its scarce resources in the areas where maximum potential for development existed. Consequently, farmers with scarce resources were excluded. For example, crop research has been focused to develop the large areas covered by predominant cropping patterns. It was assumed that the technologies would trickle down to the resource-poor farmers having the minor crops-based cropping patterns. In Nepal as elsewhere, this trickle-down process did not happen (Knipples et al., 1984). In order to help the poor farmers who live in low-altitude areas where the soil is less fertile and rainfall is low, a special breeding and selection program with low inputs (without fertilizer) has been planned. Groundnut, sorghum and tobacco, which otherwise are the minor crops but are vital for the people of these areas, have been included in the research program. Farmers from occupational castes who are poor are provided with free pigs with arrangement to pay back later in kind in the form of one piglet (Pers. Comm. N. Shrestha and P. Chemjong, 1988). Existing groups of the Small Farmers Development Programs (SFDP) are given free packets of seed under the minikit program. PAC thus has changed its approach from a progressive-farmer, predominant-cropping pattern-based model to cater to the previously neglected, resource-poor fanners.

Response to Diversified Needs of Farmers

One maize variety was recommended for each land type and altitude. This approach has been reasonably successful, but a similar approach for rice did not work well. It was later discovered that the group of farmers consuming maize was fairly homogeneous while rice consumers varied quite widely. A variety of rice (Pokhreli masino) with all the 'desirable characteristics'—long, fine and aromatic grains, good grain and straw yield—that could be grown in the mid hills where such varieties are not found, was criticized by the poor farmers. They complained that they tended to eat more of it and that it did not give a full feeling because it was digested quickly, hence it was not good for laborers working in the fields. This forced the researchers to consider the different requirements of different classes and areas; thus the socioeconomic perspective of the farmers' needs has now been included fully in the research program.

Farmers Identifying the Opportunities

The construction of a motorable road has opened this area to a wider market access in the plains. The farmers close to the roads have started planting more market-oriented crops, mostly vegetables. Marketing studies have also identified a potential market for off-season vegetables for the plains, which could be supplied from the hills. PAC now has responded with a suitable vegetable-production program for the farmers of these areas. Previously, vegetable seed production was almost nonexistent for commercial purposes. After farmers

found out that both PAC and the Agricultural Inputs Corporation (AIC) were willing to buy vegetable seed, they began growing vegetables for seed, and many farmers have subsequently benefited. In one case, a farmer was able to earn net Rs.2520 from an area of 500 m^2 by selling seed. With the traditional crop (dinger millet) he would have earned much less (Rs.700). The farmer in this case had planted broccoli from which he also sold fresh vegetables worth Rs.200. Farmers near the road have also demanded more poultry for which there is a good market.

LINKAGES

Farm Level

Linkages with the farmers are maintained at different levels. There is a direct contact of the trainers with the trainee farmers during training courses. Extensionists meet the farmers very frequently in the field, and researchers also visit and talk to farmers while conducting OFR programs as well as during the Samuhik Bhraman (Joint Treks). These linkages with farmers have been instrumental in bringing the farmers' perspective to the PAC programs.

Intersectional

A Technical Committee is in existence with representatives of all sections at PAC. Once a year the center has an annual review and planning meeting at which the annual work program is agreed upon. Twice a year during the in-service training, the extension staff and researchers meet and discuss the problems of farmers and the reaction of farmers to the recommended technologies. A seed committee with members from all concerned sections meets to discuss crop varieties and quantities of seed to be multiplied, acquired and distributed. Weekly seminars draw scientists from all sections. The Samuhik Bhramans have further enhanced the intersectional linkages. These linkages have been found important to create understanding, avoid duplication of work and establish cooperation. However, until recently very few programs dealt with problems relating to more than one section. An innovation has been the establishment of working groups to cover specific problem areas.

District Level

A strong link has been established with the District Agricultural Development Office through the minikit program and as well as with the AIC and Agriculture Development Bank and the cooperatives through the district-level seed multiplication program. The minikit program is an old one that was carried out by the National Crop Development Programs (NCDPs) and the ADOs. Very often inappropriate varieties were sent to the hills, often too late to plant due to transport problems and distances involved. PAC's involvement in this program is to supply recommended varieties suitable for the region at the right time. This has led to the increase in feedback from the minikits. The seed production program involving the village-level contract farmers with the joint support of PAC and district-level agencies (AIC, ADB and Cooperatives) has also been a successful model (Bhattarai et al., 1985).

Regional Level

PAC, at present, is working as a research and resource center for the KHAP, a large integrated program in the region. It also provides the research input and expertise to the Mechi program (Dutch Project) in the adjoining zone.

National Level

PAC has established good links with all the NCDPs and worked as the testing site on behalf of these programs. The linkage between the two has been a very effective one. For example, crop varieties developed and verified by PAC, i.e. Manakamana-1 maize, Annapurna-1 and Annapurna-2 wheat, have been nationally recommended on a joint proposal of PAC and the concerned programs. PAC has been designated as the regional research center for the Eastern hills by the National Agricultural Research and Services Center (NARSC) and has been included in the mainstream of the national agricultural research network. PAC also has been made responsible for seed inspection and certification of the Eastern hills for the central government seed program.

These national-, regional- and district-level linkages of PAC mean that PAC has a wider area in which to implement its technological recommendations and the opportunity to serve more farmers. This also is helpful in spreading the cost and increasing the cost effectiveness of PAC's programs.

SUSTAIN ABILITY OF THE SYSTEM

A few years ago great concern was expressed over the sustainability of PAC programs, because PAC had developed its own system and infrastructure that is different from that of the existing government system. Now, since the PAC model has been largely adopted by the NARSC outreach research plan, the PAC system will be compatible with that of the government. The laboratories (seed, veterinary) have also been recognized as the satellites of the national laboratories. Some unique programs are also being rationalized to make them compatible. After a long time, an autonomous project operating with an effective program of its own has been successful in convincing the government to change its policy and adopt a proven adaptive model appropriate for hill situations.

ALTERNATIVE METHODS AND NEW APPROACHES

Informal Research and Development

Larger plots (500 m^2) were required for on-farm verification trials to make economic analysis possible as well as to give them a demonstrative effect. No compensation was offered if a trial failed. This led to the OFR programs biased against the poorer farmers who could not take the risk of crop failure because of their small holdings. Similarly, the programs also excluded poorer farmers from the contract seed grower program because whatever they produce they consume and no seed can be bought back from them. Still, there was a need to help the farmers, and a study of informal exchange of seed from farmers to farmer (Green, 1987b) showed that there was an alternative. Several people have suggested (e.g. Biggs, 1988) that getting farmers to 'test' the technology using their own 'experimental design' was possible. A program of providing seed packets of promising varieties to the small farmers as well as to a large area has been started. The site selection, planting and management are carried out by the farmers themselves. Only the introduction of the variety is by researchers. The initial indication from this program has been very positive; this has not only helped the farmers but also has complemented both research and extension, established good rapport between farmers and researchers and aided understanding of farmers' preferences in a shorter time with a relatively low cost, effort and staff involvement. Although the monitoring and evaluation of the program takes more time, the beneficial effect of the approach cannot be underestimated.

This program also incorporates the experiences of farmers with new technologies. For example, a few years ago in the rice varietal FFT, farmers themselves identified a rice variety suitable to grow under shade (JC 24) that was not detected in the combined data. Now this variety is popular under those circumstances. The feedback from the farmers has been invaluable to researchers who have now plans for acquiring the seed back and testing it widely under shade. These examples of informal research and modification of the technologies by the farmers to suit their needs have been helpful to redefine research objective and approaches.

Diamond Trials

Initially PAC adopted the IRRI model of on farm, farmer-managed, pre-production verification trials that was a non-factorial design based on two treatments: 'improved'—technology-improved variety with improved husbandry packages-and 'local'--farmers' variety under farmers' husbandry system. Later to make the model more relevant and effective, PAC modified it to a diamond trial, which is an on-farm, large-plot (125 m^2) farmer-managed trial with four treatment in a 2 x 2 factorial design, and the treatments are usually two levels of variety (farmers' and improved) and two levels of husbandry practice (farmers' and improved). All husbandry variables other than those being tested follow the farmers' normal practice. This has made it possible to compare local versus improved package, local versus improved variety, local versus improved husbandry and the interaction of variety x husbandry. This has increased the efficiency of research with a small marginal cost. The statistical precision has also increased due to the increased residual degrees of freedom. Diamond trials also challenge the assumption that technologies must be packaged and that improved varieties should always be cultivated with fertilizer. Experiences with these diamond trials have proved that technologies can be de-packaged to great effect (Green, 1987a). The diamond trials have now been adopted by other projects, e.g. LAC and Action Aid, as a part of their on-farm research.

Samuhik Bhraman (Joint Treks)

The Samuhik Bhraman has been described by several workers (Beeb, 1985; Mathema and Gait, 1987; Bell, 1986; Gaudin and Green, 1987). The Samuhik Bhraman is a multidisciplinary activity that combines the best

aspects of the 'combined' and 'group trek' activities of Lumle (LAC) and Pakhribas (PAC) Agricultural Centers (Mathema and Gait, 1987). All of the initial work on combined and group working treks in Nepal was done at these two research station (Bell, 1986). The Samuhik Bhraman that are carried out with the multidisciplinary teams have some key features-clear objectives agreed beforehand to assess the development potential and problems of a limited area, to review PAC activities and to recommended change in PAC research and working methods. These Bhramans have also identified successful technologies (developed by PAFC or farmers) that may be extrapolated to other areas by talking informally with community leaders and farmers (Panday et al, 1986).

This practice has been found very useful in understanding farming systems, prioritizing the research program and establishing cooperation between different agencies and personnel working in the same field. It has also been effective in bringing out personnel from the NCDPs who could then understand and appreciate the problems and priorities of the hill farmers. However, it should be remembered that the Samuhik Bhraman approach is new and evolutionary in PAC, and it has been changing to meet farm-level needs and realities.

Rationalization of Programs

Input supply (mostly seed and animals) has been one of the major activities of PAC. Since this system has been continuous, it has made the farmers more dependent on external resources, so a number of changes are now being made. Farmers are being trained to select and store seed and manage it themselves so that they will be self sufficient in seed. A similar program of establishing nucleus animal breeding centers in the Panchayats has been started. These are then the sources of improved animals for the area. Private nurseries for fruit trees, cash crops (e.g. Cardamon) and forestry are encouraged The extension program has been rationalized by making it responsible for the extension of crops, livestock and forestry instead of one extension section for each. This is the first step taken to rationalize PAC activities to make them more sustainable.

FARMING SYSTEMS AND INTERDISCIPLINARY RESEARCH

The foregoing discussion of PAC history, organization, structure and working experience indicates that over a short period of time the center has moved a long way towards the development of a farming systems perspective and approach to research and extension. The program does incorporate many of the features that are considered to be essential in FSR/E, namely to be problem solving, multidisciplinary and interdisciplinary, farmer-client oriented and iterative and have a holistic approach, a focus on food production and security and linkages with other scientific programs.

However, it can also be seen that there are some deficiencies in the present approach that could be removed. First, many of the modifications in the direction of the program have come about through ex-post findings and analysis. Second, there is still some overlap in activity, particularly where a problem falls between disciplinary or commodity division. Third, the full implications of the identification of an important linkage within the system are not carried through to the implementation of interdisciplinary working programs. And fourth, there are major areas of research (e.g. soil fertility and conservation) that have not been considered to be the responsibility of any particular section or program until recently.

To address some of these problems, PAC has set up a series of working groups.[2] These include farming systems, soil fertility, fodder, regenerative technologies, women's development, information and research and extension methods.

Each group consists of six to eight staff members drawn from different sections of the center, and each has terms of reference that cut across existing disciplinary boundaries. The general objectives of the groups are to examine problem areas in an interdisciplinary manner, to increase the level of participation and interaction between scientists, extension staff and farmers and to plan, guide and implement appropriate research in these areas.

It is too early to say how effective this approach will prove to be, but initial results are encouraging. Inevitably these groups will change in number and form and evolve over time. It should be noted that the center has, for the moment, decided against the focus of effort on specific village or panchayat sites for farming systems and interdisciplinary research. This approach has been adopted by the National Farming System

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[2] Lumie Agricultural Center has organized three major “thrusts,” soil fertility, fodder and income generation, that carry out work in an intensive manner at a series of representative sites in their command area (Bell, 1986; Seeley, 1988). A similar idea was recently proposed by Byerlee and Tripp (1988).

Research and Development Division (Panth et al., 1987) and to some extent by LAC. By adopting this approach, it is hoped that PAC staff can all consider that they have something to contribute towards FSR/E and not leave it to a particular section or group to carry out this work.

Of particular interest to this meeting is the setting up of a Regenerative Technology Working Group. This group has a particular concern over the development of systems in the Terai and accessible lowland within the hills that are dependent on exotic inputs such as fertilizer and pesticides. The group has begun work on the collection of information on methods of crop and livestock protection that rely on local materials, the further development of composting and manuring technology, alley cropping with a mixture of local and exotic species in hedgerows and other systems of resource management that concentrate on stability rather than short-term physical productivity as a primary goal

CONCLUSIONS

An agricultural center, originally funded by an external donor over 15 years ago with a very specific mandate, has evolved to become an important component of and a leading innovator within the National Agricultural Research System. The assurance of adequate funding and support has enabled the center to build up a core of active, well-trained and -motivated staff, and the regular technical inputs from outside have ensured a regular flow of ideas from other research systems.

Much of the innovation has come from the field operations experience of professional and local staff who have shown a high degree of flexibility and ability to modify the program in response to the changing needs of farmers and communities in the diverse hill environments of the Eastern hills. The major challenge ahead is to develop greater degrees of self sufficiency of supply and needs among farmers and farmer groups, to halt the decline in soil fertility, to support farmer innovation practices that increase stability of farming systems and to provide adequate income for resource-poor farmers. This can be achieved only with the cooperation of many agencies working in these areas and with both policies and planning that are sympathetic to the needs of poor hill farmers.

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Table 1. farm size and type of land (khet or bari) in the Koshi Hills, Nepal

Farm Size (Cultivable area) ha	%of farms (total)	% of farms by land type				
		Only Bari	Mainly Bari	Bari Khet	Mainly Khet	Only Khet
Less than 0.25	19.8	53	7	32	5	3
0.26 - 0.50	23.5	21	14	32	28	2
0.51 - 1.00	30.6	15	18	31	36	1
1.01 - 1.50	11.1	10	20	30	39	1
1.51 - 2.00	5.8	10	1	23	45	1
2.01 - 2.50	3.5	14	22	29	35	0
2.51 +	5.7	10	23	42	25	0

Note: Only Bari farms are 100% Bari.
Mainly bari farms are over 70% bari, less than 30% khet.
Khet-bari farms have 31-60% khet.
Mainly khet farms have over 60% khet.
Only khet farms have 100% khet land.

Source: Conlin and Falk, 1979.

Table 2. Time allocated to be spent by the crop research staff on the farmers' field.

S/No	Staff	% time in the farmers' field.
1	Chief Agronomist	25
2	Agronomist (On-station) (1)	20
3	Agronomist (On-station) (1) (includes sub-station)	40
4	Senior Agronomist (Out-reach) (1)	45
5	Agronomist (Out-reach) (4)	60
6	Assistant Agronomist (Out-reach) (5)	75
7	Senior Technician (Out-reach) (1)	40
8	Junior Technician (Out-reach) (4)	80
9	Junior Tech. Asst. (Out-reach) (18)	95
10	All JTs/JTAs (On-station)	10

figures in the parenthesis indicate the number of staff.

Table 3. Women's participation in the kitchen garden program.

Year/Season	Participant	Household (%)
1986/Summer	2	0.04
1986/Winter	42	1.00
1987/Summer	110	2.64
1987/Winter	216	5.18
1988/Summer	319	7.77

Source: Thapa, 1988

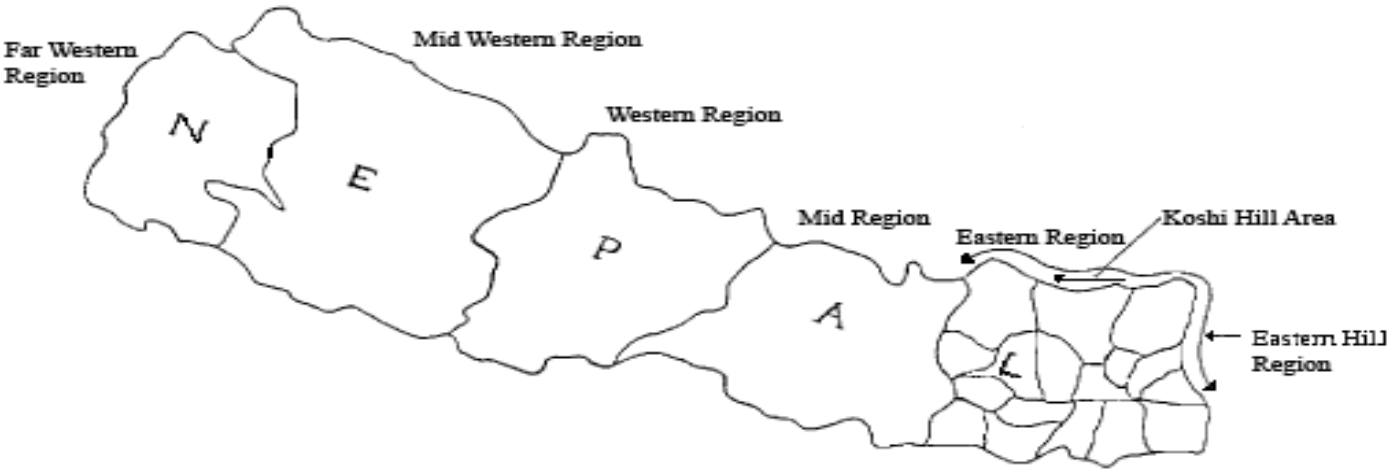

Fig. 1. Map of Nepal showing the Eastern and Koshi Hills.

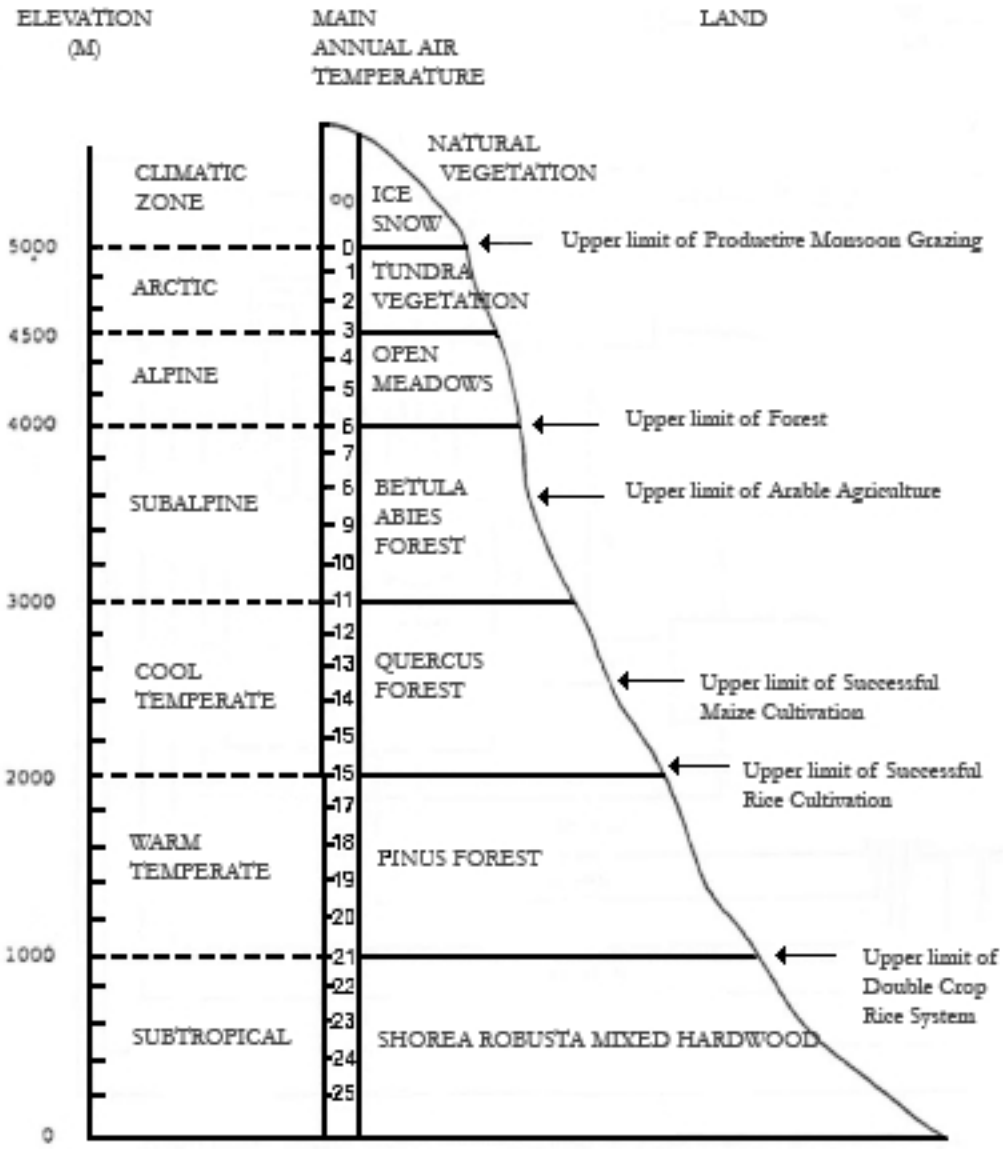

Fig. 2. Inter-relationship between altitude, mean annual temperature and land use limits in the Eastern Hills of Nepal.

Source: Fonzen and Oberholzer (1984).

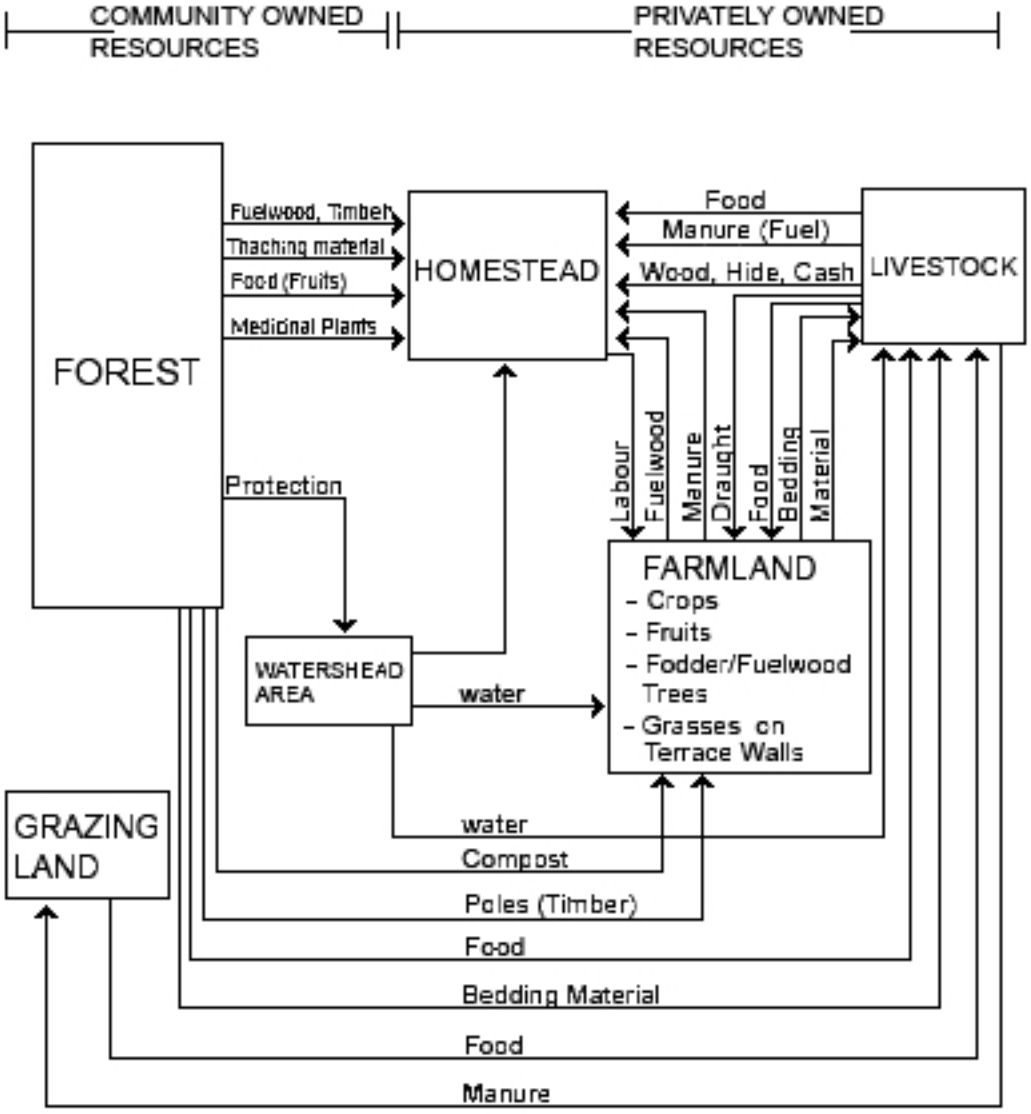

Fig. Conceptual model of Nepal hill farm production system. Source: Thapa (1987).

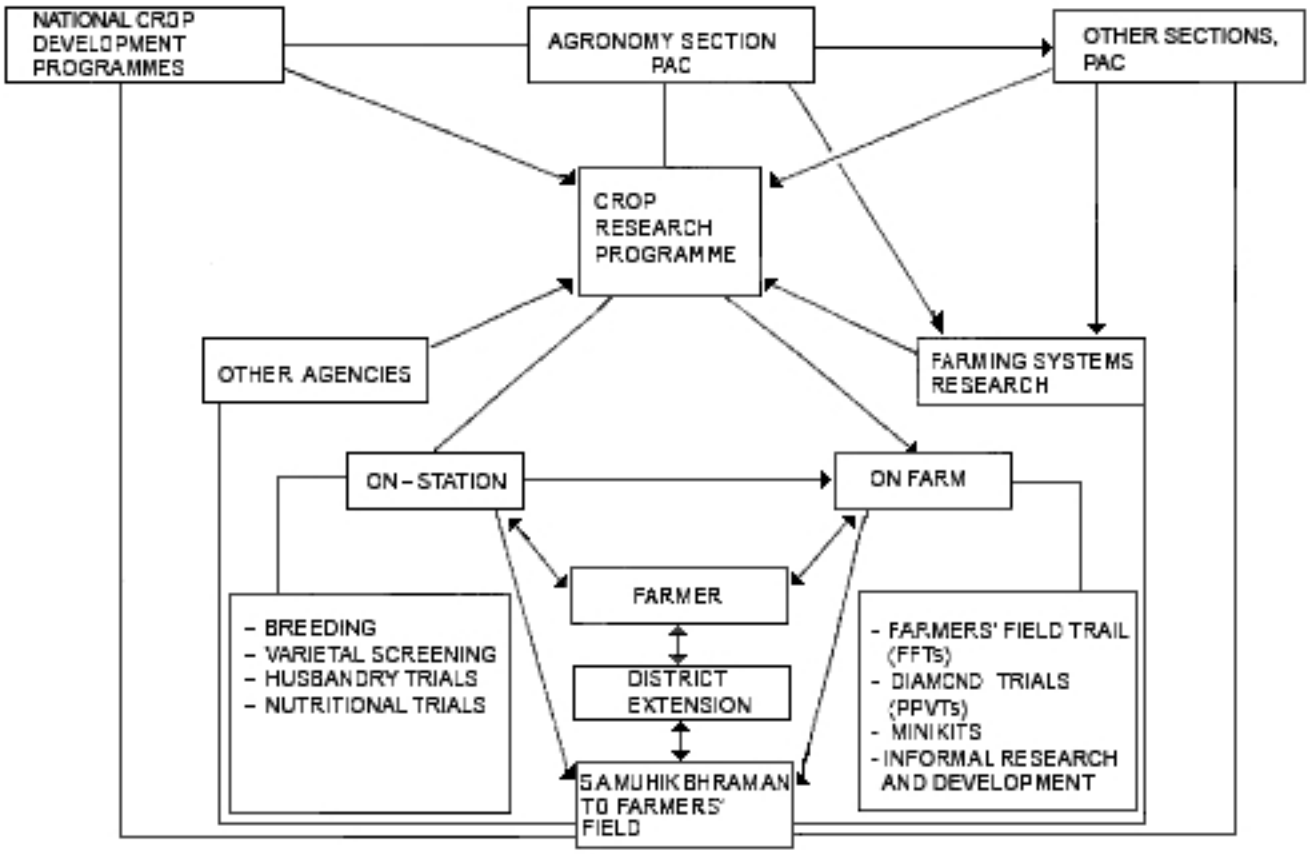

Fig. 4. Crop research procedure at Pakhribas Agriculture Center.

SOME RELEVANT FEATURES AND CONSIDERATIONS OF FARMING SYSTEMS RESEARCH AND EXTENSION: POLICY AND PRACTICE IN SOUTH AFRICA

Ted Stilwell, Johan Van Rooyen and Leon Gouws

INTRODUCTION

Agricultural researchers, extension workers and developers are faced with the problem that modern improved technology is often rejected by small farmers in developing areas all over the world. Modern management practices, crop and livestock production systems, irrigation systems, pastural practices, improved hybrid seeds and highly productive livestock breeds are ignored or only partially adopted (Rose and Tapson, 1984; Winkelmann and Moscardi, 1982).

The reason for the lack of progress in the developing world is generally ascribed to factors such as lack of information due to poor communication and extension, lack of resources (land, production inputs and credit), lack of support systems, lack of infrastructure (roads, dams and telecommunications) and lack of marketing facilities (Harwood, 1982).

These common problems apply to the developing rural areas of Southern Africa as much as to any other area in Africa or the world. In addition, there is restricted access to the support systems available to smallholder farmers in Southern Africa (van Rooyen et al., 1988).

In addressing these problems, a systems approach is proposed in order to assess the impact of a great number of variables. It is also important to recognize that within a systems approach, the human/social subsystem controls the natural/physical/technical sub-system, while the economic/policy sub-system provides the basis for decision-making. A deficiency in any one of these sub-systems or in synergy between any two would cause sufficient distortions to result in systems failure. It thus is imperative that in considering technology transfer, the human/social system (bottom-up) and economic/policy (top-down) system should guide technical systems planning and design. FSR/E methodology fully recognizes the smallholder farmer, as entrepreneur and production agent, as central to development efforts.

THE SOUTHERN AFRICAN CONTEXT: TWO AGRICULTURES?

A realistic assessment of the agricultural economy of Southern Africa indicates a highly diversified saturation. Agriculture is inter-linked in a common economy with various levels of interaction and cooperation (van Rooyen et al., 1987a).

Agricultural production activities occur within a wide range of farming systems. Capital-intensive commercial farming exists alongside subsistence production units. Large-scale agricultural estates and privately owned family farms operate within sight of communally orientated tribal farming systems. Differences are further accentuated on the production side. White commercial farming produced an output of R1 298/man and R119/ ha cultivated, in comparison to R65 and R34, respectively, in black agriculture (Natrass, 1981). Although this type of comparison may not be absolute, it substantiates the considerable differences prevailing in agricultural production levels in Southern Africa.

To a large extent, the diversity of agriculture in Southern Africa relates to the entirely differentiated milieu in which agricultural activities occur. White commercial farming is comprehensively supported by specialized institutions such as the SA Land Bank, specialized financial institutions, marketing boards, the cooperative movement, Organized Agriculture, research, extension and input supply institutions as well as strong political lobby. Subsistence and smallholder agriculture, on the other hand, operate largely outside this support structure (van Rooyen and Fenyes, 1985). In developing agriculture, strategies were, until recently, characterized by large, semi-state and centrally controlled corporate projects with relatively little attention towards the establishment and support of individual smallholders and commercial black farmers in their own right. In this context, it

[1] Division of Rural and Agricultural Development, Development Bank of Southern Africa.

is important to contrast this centralistic approach with the widespread evidence that smallholders in developing agriculture are basically economically efficient in their allocation of farming resources. In cases where these farmers have been comprehensively supported, it has been observed that they respond rationally and dramatically to price signals and economic incentives if allowed to do so (Norman, 1978; Low, 1984; Ndimande, 1986).

The existence of successful, albeit relatively few, independent commercial black farmers must also be appreciated as these farmers operate commercially despite the numerous restrictions facing them in relation to access to farming resources and support systems.

Differences in the Southern African agricultural economy are thus quite apparent. However, it will be incorrect and an over-simplification to view the prevailing situation as that of "two agricultures" existing in virtual isolation alongside each other.

Economic forces and market realities negate this notion. A few examples in this regard will suffice. Research indicates labor allocation in rural households as a function of the economic returns to agricultural employment opportunities. Increases in non-agricultural wage levels will consequently raise the opportunity costs of agricultural activities and decrease the attractiveness of farming (Low, 1984; Stewart, 1986); commercial producers in Southern Africa, whether large or small, black or white, produce in a common market. Over supply of a particular agricultural commodity will ultimately be penalized with decreasing producer prices affecting all producers in Southern Africa. Marketing arrangements such as quotas and permit systems and agency agreements between SA Marketing Boards and some of the National States are further examples of the economic interaction between the various agricultures in Southern Africa. The openness of the Southern African economy further emphasizes the necessity to acknowledge inter-linkages within agricultural markets.

These features of diversification should be viewed as representing the spectrum of visible supply and demand interaction and occurrences within the wider Southern African economic and political milieu. Such an assessment leads to the consideration of strategic policy issues for rural and agricultural development.

STRATEGIC CONSIDERATIONS FOR RURAL AND AGRICULTURAL DEVELOPMENT

The emphasis placed by the present economic development policies in Southern Africa on the application of sound economic principles and criteria, on the devolution of decision making and responsibilities and on support to private-sector activities would focus pertinent attention and affirmative action towards farmers (full or part-time) in the developing areas. It would be important to design agricultural policies, strategies and farmer models with support to and settlement of farmers as major objectives (van Rooyen et al., 1987b). This approach calls for the redirection of present agricultural development policies towards opening access for farmers and all users of agricultural resources to the common input and product markets. This further implies emphasis on farmer support programs as well as agricultural interaction and economic cooperation within and between regions in Southern Africa. These features should be considered as important within the design of a Southern African food policy as they deal pertinently with resource allocation on macro as well as micro levels.

In the preceding section, the point for a substantial role for agriculture in economic development strategy for Southern Africa is evident. From the various arguments, it is clear that a restructuring of the Southern African agricultural sector is required to ensure that the major conditions for agriculturally based employment and income growth are met. Some of these conditions are now discussed.

Equitable Access to Participate in Agriculture

It would be important to ensure that farmers everywhere in Southern Africa have equitable access to opportunities to compete in the market with pertinent emphasis on integrating black "emergent" smallholder farmers into the commercial economy. This will promote the economic optimal utilization of agricultural resources and generate important income and employment linkages in the other sectors in the economy. Various aspects in this regard would require attention. This point is comprehensively argued by van Rooyen et al. (1987b) where the case of opening access for smallholder farmers in the developing areas by means of Comprehensive Farmer Support Programs (FSP) and affirmative action is presented.

Within the Southern African context, the entitlements of smallholder farmers and black commercial farmers are severely restricted by various factors such as the lack of de facto production rights, limited exchange opportunities to trade in the wider South African economy, limited opportunities to transfer assets and labor to higher returns, legal restrictions, etc. The success of FSP and the entry of black farmers into commercial agriculture would depend to a major degree on arrangements to ensure success and to improve entitlements of these farmers.

Adjusting the Present Distribution of Agricultural Resource Endowments

An access and entitlement approach to agricultural development will inevitably direct attention towards the present availability and distribution of agricultural land resources in Southern Africa. Regardless of the political sensitivity of this issue, it must be appreciated that individual restrictions to access and entitlement of land would jeopardize the long-run economically optimal utilization of land resources while effectively undermining private enterprise initiatives in agriculture. Land issues in all states in Southern Africa will receive increasing attention in the future and should be placed on the agenda (de Klerk, 1986). It is necessary that this issue be assessed within a sound economic framework attending to efficiency and equity criteria and not solely in terms of its political considerations (Fenyes et al., 1986). An evolutionary approach is proposed with emphasis on increasing the productive value of land and stimulating an informal land market, utilizing farming opportunities around urban complexes and smallholder farming in marginal land areas.

Comparative Cost Considerations and Cost-Benefit Analyses

The principle of market-related economic activities requires that sound economics dictate the location and establishment of agricultural activities. With present efforts to stimulate the economic potential of the less developed areas of Southern Africa and the opening of access to all farmers to compete in the market, the application of the principle of comparative cost advantages may imply certain shifts in production localities to ensure the economically optimal utilization of scarce agricultural resources and markets (Ortmann, 1986).

Historical occurrences and infrastructural development, which may have, for example, prevented developing areas from competing cost-effectively in the market, would have to be discounted in terms of social cost benefit considerations favoring a shift in locality.

Availability of Appropriate Technology

The appropriateness of available technology in Southern Africa needs to be thoroughly assessed in terms of future requirements. Both biological technology (seeds, pesticides, etc) and mechanical technology have reference here.

Commercial agriculture is presently characterized by over-investment with emphasis on expensive imported technology and on large-scale machinery (Groenewald, 1987). Restructuring in this regard should be towards less expensive, local and possibly more modest mechanization equipment.

Smallholder farming, on the other hand, lacks the financial resource base to register needs for appropriate scale neutral or small-scale technology in the market. Technology and mechanization are viewed as some of the most prominent inputs required to modernize developing agriculture, improve productivity and promote equity based development (Mellor, 1985).

A system to stimulate research and development towards appropriate technical inputs adapted to local conditions and to the diversity of agriculture in Southern Africa is an important requirement. In this regard, the Farming Systems Research approach, as advocated by Development Bank of Southern Africa (DBSA, 1988), van Rooyen (1984) and Rose and Tapson (1984), seems appropriate to direct attention to the biological and mechanizational needs of smallholders in developing agriculture. This approach could equally be applied to the commercial farming sector as it focuses on the farmer operating within the farming environment. Movements towards smaller family farms will benefit from such an approach. The changing labor market should also be assessed when optimizing technological packages.

Restructuring of Institutional Arrangements

The promotion of local "emerging" private sector capacities at agri-support levels should be viewed as an important priority in spite of possible inefficiencies over the short run. In this regard, attempts to institute greater centralization and control in the organization of production in developing agriculture should be viewed as unproductive, and counter measures directed towards a sound long-term development strategy, aimed at creating capacity and greater sustainability at local and individual levels, local "grass roots" organization, should be promoted where possible. Cooperative movements should, for example, be promoted and based on collective action activities at grass roots level, rather than on a "top-down" approach enforced by government.

Integrated Rural Development

Agricultural development strategies should increasingly be viewed within a rural context. Such an approach will focus attention on agriculture's leading role in development, namely stimulating forward and backward linkages and multipliers in the local, regional and national economy.

The optimization of rural linkages will, among other things, be achieved by stimulating and supporting local initiatives and small emerging entrepreneurs to cater to required agricultural services, e.g. marketing, mechanization contractor services, transportation, etc. Establishing the required infrastructure, e.g. roads, dams, fencing, etc, should also essentially be entrepreneurial-intensive with considerable opportunities for small entrepreneurs to become involved.

Support to communities in productive activities such as home crafts, cultivation of food crops, etc, by communities and individuals who do not have access to sufficient land would also be pertinent in the integrated rural context.

From the above, the following development models can be identified: Farmer Support Programs (FSP); Farmer Settlement Models (FS) on projects; and Community Support Programs (CSP).

ACCESS FOR SMALLHOLDER FARMERS: THE FSP APPROACH

In order to provide access and entitlements to smallholders in agriculture and a structure investment in an efficient and effective manner in this process, the FSP approach is proposed, in which the following pertinent elements (Haasbroek et al., 1988) need to be attended to:

1) the adequate provision of appropriate input and on-farm infrastructure, and the funding thereof (credit), to the farmer;
2) the provision of a comprehensive mechanization service, which caters to all aspects of transportation, land preparation, planting and cultivation (harvesting and transport to storage may also be required), as well as the maintenance of machinery, implements and infrastructure;
3) the provision of marketing channels and services to cater to all aspects of marketing should this become necessary (i.e. grading, storage, packaging and transport);
4) specific development-related research to ensure that maximum opportunity can be made of existing and new technology and the provision of adequate extension, information and demonstration services;
5) the provision of training and management support to facilitate the development of managerial skills needed, both on the farm and at an institutional level;
6) the acquisition by individuals of de facto rights to production that would include land security, contracts and quotas;
7) the provision of off-farm agricultural infrastructure necessary to support FSP. The provision of this element differs from that of on-farm fixed improvement and is seldom paid for directly by the farmer. The following are seen as specific to the FSP: feeder roads and bridges, to facilitate access to farm and service centers; fencing, such as boundary and roadside fencing and around planned agricultural areas; conservation works, such as contours and soil erosion works; and finally, the planning necessary for the above. It should be noted that the infrastructure necessary for communications and the electrification of rural communities, while important for the FSP, should be seen in the context of more general rural development.

A deficiency in any one of the above or in the synergy between any two could cause sufficient distortion in the system to result in failure. A pertinent planning activity would, therefore, be the harmonization of the above elements in a systematic manner. Sufficient evidence exists that a farming systems approach is central to any policy formulation of FSP (Harwood, 1979; Bembridge, 1982).

In this context, FSR/E can be identified as one of the crucial elements in addressing development problems (Rose and Tapson, 1984). Within an FSP policy framework, it is evident that FSR/E would address the whole spectrum of operational support elements, i.e. production inputs, equipment, marketing and infrastructure.

As an integral part of the development process, the role of FSR/E in development policy and strategy also warrants further detailed consideration.

The goals of FSR/E should be in harmony with the overall development policy objectives of a particular state or region, and its role should be to support overall development policy. It should thus focus on national objectives and the farmers' requirements for improved technologies (Gamble, 1984). Goal incongruence between any two of the national objectives, farmer objective functions and FSR/E objectives would result in FSR/E not being adopted, and thus failure of the research effort.

It should not be argued that FSR/E should be subordinated to national objectives as this may unnecessarily restrict its role. Rather, FSR/E should be viewed as supportive of national objectives in developing the

necessary perspectives on farmers' objective functions and proposing appropriate technological, institutional and economic interventions that should be adopted into national or regional policy formulation and objective statements.

FSR/E IN SOUTHERN AFRICA

Within the Southern African context, the rural and agricultural objectives and proposed strategies for reconstruction are the promotion of economic, social and structural change away from subsistence farming towards farming systems of a more commercialized nature in order to bring about greater economic growth and welfare and allow the lesser developed regions to contribute positively to the Southern African economy.

Within this framework, the ultimate goal of FSR/E should, therefore, be to promote economic, social and structural change in smallholder farming induced by technological transformation. A failure of FSR/E to lead to national FSP or to enhance the efficiencies of FSP would be deemed ineffective.

The FSR/E approach toward development has been introduced into South Africa only fairly recently (van Rooyen, 1984; Rose and Tapson, 1984). Four case studies providing an insight into policy and strategic approaches towards FSR/E are highlighted below.

Ciskei Small Farm Systems Research

The researchers, the Agricultural and Rural Development Research Institute (ARDRI), University of Fort Hare, considered that an appropriate research model should have three basic phases, as adapted from the Cornell University farming systems research program:

- diagnostic phase;
- research phase; and
- implementation phase.

Because of the critical lack of detailed knowledge of the realities of rural areas, the diagnostic phase was based on two techniques: benchmark surveys to establish the status quo in, and constraints imposed upon, the community by both technical and human elements; and felt needs surveys to determine the goals and aspirations of rural people and the perceived problems and development priorities.

The research phase would compromise research station research and on-farm research in the farmers' fields by way of adaptive research to address the needs and constraints faced by people. In addition, it is intended to implement promising practices by extension to surrounding farmers and extension agents (Rose and Williams, 1988).

Rose and Williams (1988) report that to date the focus has been primarily on the diagnostic phase. Some of the relevant features of the rural profile are as follows:

- nearly one half of household heads are older than 60 years of age;
- a high portion (30-40%) of de facto heads of rural household are women;
- of the heads of household younger than 60 years, two-thirds are employed off-farm;
- 21% of wives are also involved in the off-farm labor force;
- only half the households have arable land (3 ha average), and only 42% of that land is cultivated at any one time; and
- 94% of household income (US$1100 average per annum) is non-agricultural in origin (Rose and Williams, 1988; Eckert et al., 1988)

The problem facing researchers is in identifying smallholders who are "farmers" and for whom farming is of significant interest. Eckert et al. (1988) report that this may embrace only 15-20% of rural households. In identifying such farmers, a significant correlation was found between agricultural enterprises. For example, farmers with a larger hectarage also have larger areas of winter crops, most animal species, farm implements, etc, whereas most farming systems research programs concentrate on median farmers. The task differs conceptually in the Ciskei as most landholders are only passively interested in agriculture, and research should therefore be concentrated on "progressive" farmers as the only smallholders interested in agriculture. Eckert et al. (1988) found that the two most effective classification systems in identifying active smallholder agriculturalists were those possessing four or more stock species or those possessing cattle.

The Biyela Integrated Rural Development Project

The approach taken by the researchers, the Institute of Natural Resources (INR), University of Pietermaritzburg, differs significantly from that taken by ARDRI. The emphasis of the research was placed on the optimum use of resources and maximum human and economic development under sustainable systems.

At the outset, development committees representative of local communities were formed. A pilot project scheme was developed comprising of two small dairy farms, three broiler units, three egg units, six afforestation units and a community garden (Pollet, 1988).

Pollet (1988) reports that, although the egg unit proved to be a viable enterprise (US$1492 over 341 days net farm income), few local people have expressed interest in becoming egg producers. The simpler broiler production system with a quick turnover is preferred, and several requests have been received from members of the local community for assistance to establish similar units.

The two small dairy units have failed due to the advanced technology employed (e.g. oestrus synchronization) and resultant demotivation of participants. However, another local smallholder, after observing the dairy trials, initiated a dairy farm on his own accord and has subsequently approached the INR for assistance.

The community garden operated collectively by a local women's group has been successful, and positive institution-building aspects have resulted. Initially, there was doubt as to whether the afforestation on the steep uplands would be acceptable to the local community. The interesting aspect is that after initiating afforestation with six smallholders in 1987, the demand has increased phenomenally by another 153 applications at present.

Dry Bean Research Project

The researchers, the Department of Crop Science, faculty of Agriculture, University of Natal, state that the objective of the research is to improve bean production among smallholder farmers in Southern Africa through the development and introduction of high-yielding, disease-resistant cultivars (Mellis, 1988).

Observation of KwaZulu farmers' production systems revealed that their dry bean yields were mainly affected by rust *(Uromyces appendiculatus)* and bean common mosaic virus (BCMV). Materials made available by the Centro International de Agricultura Tropical (CIAT, Colombia) and introduced into local breeding programs has resulted in the development of disease-resistant, high-yielding cultivars adapted to the local conditions. These cultivars were released through farmers' days, courses for extension officers, demonstration plots and distribution of 1,000 200-g packets of seed among farmers. The objective was to introduce the farmers to the new cultivars and give them the opportunity to compare these with their traditional cultivars. Agricultural extension officers and farmers were asked to give a report back on the performance of the new cultivars. Mellis (1988) reports that the new cultivars have been well accepted with farmers making seed available to their neighbors. Also, a commercial seed company (Agri-Aid) has taken over the distribution of seed on a national scale.

The Malekutu Dryland Project

The Malekutu community found that, with pressure on land and resultant decreasing bush, fallow periods and the shortage of individual family labor, the traditional system of agriculture no longer provided a reasonable return. In 1983, the Malekutu community approached the KaNgwane Ministry of Agriculture and Forestry (KMAF) for assistance and advice. KMAF, in collaboration with a private company, Chemserve Stem Hall (Pty) Ltd (CSH) initiated the development. The community formed the Thuthudani Farmers Association (TFA) to coordinate development. A research and demonstration farm was set up on the farmers' land to teach the principles of soil conservation and to identify suitable cultivars and fertilizer practices for the Malekutu area (Beck, 1988).

Beck (1988) reports that the farmers identified the need for mechanization services, and TFA purchased a tractor and equipment with financial assistance of Agriwane (the KaNgwane Agricultural Development Corporation). The research clearly demonstrated significant yield increases of maize and ground nuts planted in an inter-cropping system. Tillage practices emphasizing moisture conservation and rain harvesting further contributed to yield increases. The new systems were readily adopted, and by 1985, 170 farms were established. Committee members have undertaken that if they are satisfied with the new systems, they will teach the new methods to other farmers. At present, there are 276 farmers participating at Malekutu, of which all grew maize, 85% planted ground nuts, 10% planted guar, 68% intercropped, and 64% used fertilizer. There have also been changes in the committee structure. Initially a group of respected elders were elected; now it is controlled by a limited number of members with financial acumen and organizing ability.

Lessons Learned

In the South African context, the following lessons from the above four implemented FSR/E projects can be gained:

1) A perspective on the issue to identify farmers different from the one taken by the ARDRI project could render such research as inappropriate. If "farmers" are viewed as all rural dwellers utilizing resources to produce agricultural commodities, focus is directed towards establishing a system that would promote access to farming and community support systems and extend the area of choice to rural smallholders (van Rooyen et al**,** 1988). The structuring of FSR/E to accommodate this "supply approach" is strongly advocated as operationally a more useful approach than efforts to identify smallholder farmers alone.
2) In all the case studies, it appears as if too little cognizance is taken of the relation between household economics and smallholder farming in developing areas (Low, 1984). In both the Malekutu and Biyela projects, farming was pursued as a sustainable system, while the dry bean project did not investigate integration within the farming system. It is strongly proposed that the sustainability of systems be broadened in terms of the wider household context, assessing the impact of technological innovation within the household economy of resource use and vice versa.
3) In both the Malekutu and Biyela projects, strong farmers' committees have led to collective action in requesting assistance while risk-taking and decision-making on implementation was at the individual (household) level. The lack of an effective committee system in the Ciskei SFSR has resulted in no on-farm research being established as of this date.
4) The findings of the Ciskei SFSR in respect to the large proportion of women heads of household is indicative of the hitherto-neglected need to research and structure support specifically toward women farmers.
5) The positive correlations between the number of farm enterprises as a system of classifying effective agriculturalists, as reported in the Ciskei SFSR and, in particular, the number of types of livestock kept indicates the role of livestock in the farming system, as well as the degree of risk avoidance practiced by the farmer. The large portion of farmers adopting intercropping systems at Malekutu is also indicative of the risk avoidance strategies followed by farmers.
6) Within the development strategies and development models, i.e. FSP, FS and CSP, it would be necessary to identify research systems to address the particular needs of these various domains.

   Farmer Settlement Model Research (FSMR) would be directed at the description, design and testing of optimal institutional, technical and socio-economic arrangements that would support individual farmer settlement and participation within formal agricultural development projects.

   Small Farm Systems Research and Extension (SFSRE) would consist of the identification and study of present farming systems, the identification of major problem areas, design of the appropriate on-farm experiments and related strategies, the implementation and testing thereof by extension staff and farmers and the further extension of the acceptable findings within the broader community as part of a comprehensive FSP.

   Community Support Systems Research (CSSR) would be targeted at that large portion of rural households that do not have access to productive land or are not interested in farming and would consist of benchmark and felt needs surveys, analysis of these needs, the formulation of appropriated community support programs and obtaining commitment and participation of the community to implement those plans, e.g. village water supply projects, community gardens, sewing clubs, clinics, schools, etc.

   Present FSR/E studies address only the active smallholder farmer's requirements, and attention is needed in respect to FS and CSP.

In conclusion, it can be stated that FSR/E in Southern Africa needs to be directed towards addressing the problems faced by farmers in an integrated farm system rather than directing it at a single crop system unless the economic and social cost of adopting new technology is minimal as in the case of introducing new improved seeds. Further, given the large number of women heads of household and the large number of households not interested in farming, Community Support Systems Research should receive particular attention.

THE DESIGN OF FSR/E PROJECTS: SOME LESSONS OF EXPERIENCE

At a recent seminar on FSR/E, organized by the Development Bank of Southern Africa (DBSA, 1988), the above FSR/E projects were addressed. At this symposium, it was argued that it would be an important and necessary condition for progress to structure FSR/E according to a definite set of criteria and principles. The link with FSP was also argued.

In this paper, the following are the principles and criteria proposed to structure FSR/E within an FSP approach.

Principles

The following principles must apply:

a) An overarching goal of FSR/E should be to bring about transformation in the farming system leading to technical, economic, social and structural change where benefits are larger than the cost for the small-holder farmer.
b) FSR/E should be viewed as one element of a comprehensive Farmer Support System, and planners and designers should ensure that upon adoption by farmers, the other elements are in place.
c) FSR/E should assist policy makers and planners in the design of farmer-orientated national and regional development policy and plans or be project-related in solving problems in the planning and design and/or operation of specific development projects.
d) In the design of an FSR/E program, a milestone approach should be followed, identifying specific objectives to be reached during each step.

Criteria

The following criteria should apply.

a) FSR/E should be directed at solving the farming problems faced by the farmer.
b) FSR/E should primarily be designed within those constraints faced by the farmer over which he has control.
c) FSR/E should be adaptable enough to allow for a "learning by doing" approach to be followed by farmers and researchers.
d) The FSR/E approach should be multi-disciplinary and take into account the social, technical, financial and economic variables operating in rural communities.
e) FSR/E should seek to follow an evolutionary, rather than a radical, approach to technological innovation.
f) In the event of radical technological change being adopted by planners as the only alternative, FSR/E should seek to minimize the associated economic and social risks.

Strategies and Systems

As argued previously, agriculture should be seen as a leading sector within an integrated rural approach with strong linkages to both entrepreneurial development and community development activities. Research should be directed at these activities that would thus directly influence rural and agricultural development.

An FSR/E approach should be formulated to address the various levels of community activity.

Community Support Systems Research (CSSR). Rural households are the target groups of this research activity. This research will be directed at exposing household and community needs and devising integrated programs to meet them. In view of the importance of women in the rural household economy, spacial provision should be made for gender issues.

Farm Systems Research and Extension (FSR/E). The smallholder farmer is the target group of this research activity. The essence of this research is the development and transfer of new, improved farming systems with attention also being given to livestock and multiple farming systems.

Farmer Settlement Model Research and Extension (FSMR/E). The project farmer is the focal point of this research. FSMR/E is directed at the description, design and testing of the technical, institutional, social and economic parameters with particular reference to objective functions of farming households, the modes of decision-making on the project and institutional arrangements and physical activities.

It would further be necessary to ensure that principles and criteria similar to those applying to FSR/E should be made applicable to CSSR and FSMR/E.

CONSIDERATIONS IN THE FUNDING OF FSR/E

Research information and the acquisition of knowledge in respect of new technology is a public good. FSR/E could create economic conditions in which lesser-developed areas could make a positive contribution to the national economy.

As such, governments will have an interest in research if it is in accordance with government development policy and assists policy-makers and planners in the design of regional or national development plans or contributes to problem-solving at project level (Gamble, 1984). The benefits of research are considerable, and returns on investment of 20-90% have been reported in various countries (Gamble, 1984).

Within the proposed strategic approaches for future agricultural development policies in Southern Africa, a pro-active approach is required to test various activities ranging from policy and strategy formulation to technical innovation (van Rooyen and Vink, 1987). The Development Bank of Southern Africa (DBSA) has emerged as a major funding source of rural and agricultural projects in the developing areas of Southern Africa (DBSA, 1984, 1985). The FSP approach has also been emphasized with pertinent attention to FSR/E projects. In DBSA, the following funding guidelines are pertinent.

a) Research must be related to development policy and strategy requirements;
b) policies and strategies must be within the focus of the present economic development policies in Southern Africa;
c) specific research should be related to the promotion of the project development objectives;
d) government support and commitment to research must be forthcoming, as a coordinated effort between research, input supply on entitlements, commodity markets, training, demonstration and extension is necessary to achieve high rates of return on research investment;
e) research must be directed towards the smallholder farmer's or community's needs and opportunities;
f) research must be responsible to society, implying that the long-term interests of the general public should be kept in mind and balanced against the interest of the target groups;
g) private-sector contributions must be optimized without commercializing the economic development objectives of a research project.

Close coordination between the implementing agencies and government departments is required in order to ensure that the necessary strategic status is placed on research efforts and results are integrated into appropriate policy and strategy approaches.

This close interaction and coordination between policy formulation, strategic decision-making, farmer support, extension, demonstration and research in developing agriculture must be viewed as of the utmost importance to achieve the necessary returns on investment in the mentioned activities. To accommodate these needs and to ensure that the focus of problem solving is directed towards the farmers and his farming system, a FSR/E approach is pertinent.

CONCLUSION

FSR/E should not be viewed as an academic exercise to get involved in development, but rather as one element of a comprehensive support strategy directed towards smallholder farmers, households and communities in resource-poor situations.

FSR/E should set as its ultimate goal the promotion of technological transformation in farming systems by addressing the constraints and needs faced by the smallholder farmer, thus equipping him for the challenges of a more commercial way of life.

Within the important integrated rural development context, it is required that FSR/E be extended to accommodate Community Support Systems Research on Farmer Settlement Model Research and Extension to test new systems and, in particular, make provision for the women.

The public sector has an important role to play in funding FSR/E, and a high return on investment can be expected. However, such research should be related to the development of national policy and strategies and be based on sound principles and design criteria.

In this context, a phased approach with clear milestones should be followed, ultimately leading to large scale comprehensive Farmer and Community Support Programs aimed at ameliorating the economic deprivation of less-developed areas and enabling these areas to make a positive contribution to the national economy.

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MAKING FARMING SYSTEMS FIT

M. E. Swisher and E. C. French[1]

INTRODUCTION

Farming systems, like integrated rural development and import substitution, can become one more "buzz word" in the lexicon of extinct development terminology. The potential long-term impact of the farming systems approach to research and extension depends upon the degree to which the methodology becomes a part of the "normal, business as usual" functioning of national development agencies. The popular phrase used to describe this process of integration is institutionalization.

In this paper, the institutional history of two farming systems programs is described and compared. The first, the North Florida FSR/E program, was developed in 1980 by a land grant university, the University of Florida, in the United States. The second, in Honduras, was initiated in 1985 by a private agricultural school, the Pan American School of Agriculture. Conclusions are drawn about the potential long-term impact of the two programs on the respective institutions. The conclusions are then applied to the more general question of appropriate strategies for institutionalization of farming systems programs within national settings.

OVERVIEW

The Florida program has experienced considerable evolution over its eight-year history. In its earliest stages, it was initiated as a "pilot project" with short-term, outside funding, staffed largely by outside consultants and poorly integrated into the existent organizational structure of the University of Florida's Institute of Food and Agricultural Sciences (IFAS). Eight years later, the program has moved to an internal-funding base and has achieved at least some degree of institutional integration. Four clearly differentiated stages can be identified in this process. In this paper, they are discussed, the problems encountered at each stage are described and the overall success of institutionalization is evaluated.

The program in Honduras at the Pan American School of Agriculture (EAP, or Zamorano) has existed for only two years. It, too, was initiated with outside funding and can still be seen in many regards as a "pilot project." Institutionalization of the program at EAP was relatively simple, largely because of the highly flexible organizational structure of the institution. Serious questions regarding the potential "survivability" of the program are raised in this paper, however, since it is difficult to see how the program can be sustained.

DEFINING TERMS

An operational definition of the term *institutionalization* would include at least four critical operational parameters. The North Florida and Honduran farming systems programs will be assessed in terms of the degree to which each of these parameters for institutionalization has been satisfied.

The first parameter involves reward systems. Professionals are unlikely to commit themselves to work in programs that fail to offer adequate rewards for expected performance. Reward usually involves opportunities for both promotion and salary increase. Further, clear guidelines for achievement of promotion and salary increases are needed.

Tied to reward mechanisms is a second parameter, organizational structure. For a program to "fit" comfortably within an organization, clear lines of authority and responsibility must be established. Professionals require a stable organizational structure for their work.

Stability of funding is critical. Professionals require some assurance that their programs will receive stable funding and some idea of the level of funding that can be expected to work effectively. Stable funding is also crucial for effective program planning.

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Finally, institutionalization requires a common agreement on overall program goals, objectives and methodologies. On-going, deep disagreement among program staff and administrators regarding goals, objectives and methods not only disrupts program implementation, it also produces disquiet and uncertainty among staff members. For personnel to function effectively, they require support from other members of the institution, particularly administration who have authority over the program and its staff.

THE NORTH FLORIDA PROGRAM

The process of institutionalizing its farming systems program was not an easy one for the University of Florida. At each stage of the institutionalization process described here, certain disadvantages were discovered and steps were taken to correct the problems that had been identified. One of the major accomplishments of IFAS has been the administration's willingness to attempt to solve these problems and the institution's ability to maintain flexibility.

Stage 1: The Pilot Project

The North Florida farming systems program was originally funded by the United States Department of Agriculture. Figure 1 shows the organizational structure that was initially developed for the program. An advisory board, consisting of upper level administrators such as department heads and deans, was established. The purpose of the advisory board was to provide overall leadership and direction for the program.

The budget was housed in the Department of Agronomy as a separate budgetary item. Two faculty members were already employed at the University prior to the initiation of the North Florida program. With the inception of the USDA grant, additional personnel were added, but none of the new positions was assigned to tenure- or permanent-status-accruing tracts.

The initial "pilot project site" for the program was Suwannee and Columbia Counties in north-central Florida, approximately 60 miles from the Gainesville campus. The county extension faculty, the district extension director for the area and personnel from the regional research station, the Live Oak Agricultural Research and Education Center (AREC), were not involved directly in the program, nor were they included on the advisory board. All program personnel were housed in Gainesville. Most machinery and other equipment necessary for program implementation was purchased from the USDA grant and also housed in Gainesville.

It soon became obvious that this institutional arrangement was unsatisfactory for a number of reasons. The program was operating as a classic "pilot project," with little formal or informal relationship to pre-existing institutional structure, funds, personnel or reward systems. Most important, and well illustrated in Fig. 1, neither the Live Oak AREC nor local extension personnel had any direct input into program planning and implementation. Friction between FSR/E team personnel and personnel from local county extension offices and the Live Oak AREC naturally developed. Team members were perceived as interlopers. Team members failed to take into account the many years of experience that other personnel had in the region. Communication among the various groups was inadequate, and there was little agreement about the goals, objectives or methods employed in the farming systems project.

Further, it soon became obvious that the advisory board was not functional. Upper level administrators simply did not have the time to oversee program functioning on a frequent basis. Thus, meeting of the advisory board tended to turn in to "briefing sessions" in which FSR/E team personnel explained what they were doing. Because meetings had to be short and because board members could not keep abreast of program developments between meetings, little actual discussion that could guide program development occurred.

Stage 2: The Move to Live Oak

Even without these problems, some changes in the structure and function of the program were necessary. USDA funding was short term. While the University of Florida was committed to continuing the program, funds were necessarily reduced. It was impossible for the state to maintain the same level of funding provided by the initial USDA grant. Thus, rationalization of the program was necessary, both to solve the problems that had been identified and to permit the program's continuance. Figure 2 shows the organizational structure that was developed.

Perhaps most significant, one team member was reassigned to Extension as a multi-county agent. That individual moved physically to the study area and was housed at the Live Oak AREC. These steps greatly improved communication among local extension personnel, personnel at the Live Oak AREC and the FSR/E team. Assignment of one team member to the two county extension offices involved in the program provided

local extension personnel with input into the program and with a means of controlling program activities to at least some degree. Eventually, much of the team's equipment was merged with that of the AREC, and the AREC farm manager assumed responsibility for overseeing field work for on-farm trials.

The University of Florida made one critical advance in this period. By 1984, project funding was on sound footing with no further dependence on outside funds. Control of the budget, however, remained in Gainesville.

While the "move to Live Oak" certainly improved project implementation and institutionalization in many ways, it soon became apparent that there were still many problems to be solved. One was the fact that the multi-county agent faced a great number of masters. Since firm agreement on program goals, objectives and methods still had not been achieved; there was a tendency for this individual to be pulled in different directions to try to meet the needs and expectations of Extension, the Live Oak AREC and team members. Further, given the fact that the program remained limited to two counties, there was no effective method for upward mobility in the system for individuals who occupied this position and who wished to maintain involvement with farming systems while advancing professionally.

While the farming systems team gained increased interaction with local Extension and with personnel at the Live Oak AREC, it tended to become very isolated from researchers, including Extension specialists, on the main campus. "Outside" input (i.e. input from faculty members not directly associated width the program) dwindled greatly from what it had been when the project was housed in Gainesville. This led to further isolation of team members from their professional colleagues, increasingly inadequate communication with Gainesville-based administrators, a very narrow definition of project activities (which became reduced to only two effective foci) and an increased divergence of goals and objectives as perceived by the team and others in the university system.

Stage 3: Complete Local Integration

Again, attempts were made to adjust project institutional structure in order to overcome these problems. Figure 3 provides an overview of the organizational structure that was developed at this time. All management of the project was moved to Live Oak AREC. An additional multi-county agent was brought into the program, also housed at the Live Oak AREC and responsible to County Extension Directors in Suwannee and Columbia Counties. A local researcher and administrator of the Live Oak AREC was named project manager and assumed responsibilities for the day-to-day functioning of the program.

Notable gains were made during this period. First, outside input into program direction and execution increased enormously under the new leadership. Many researchers from the main campus became involved in the program, and the isolation of the program decreased significantly within the university. Equally important, and a direct result of increased faculty involvement, the range of program activities increased greatly. New research directions were identified and pursued. What could be described as "stagnation" in project thinking was largely eliminated.

However, there were new problems. The new project director had no formal training in the farming systems approach and did not share a common methodological approach with the previous team members. Thus, the importance of on-farm activities was greatly reduced. This decreased the level of interaction between the project and local farmers and tended to remake the project in to a more traditional research effort. The two multi-county agents associated with the program received no training in the farming systems methodology either and as a result did not tend to play a forceful and direct role in developing on-farm research. Farmer participation decreased as well.

Stage 4: The Final Fit?

Recently, the organizational structure of the project was altered again, as shown in Fig. 4. Today, both the project and the Live Oak AREC are under the direct administration of the District Director. This approach should provide for excellent coordination of project activities with local Extension. It puts both the AREC, the physical "home" of the project, and the multi-county agents under one single individual.

This solution is a particularly good one for the University of Florida. At Florida, much applied research occurs under the auspices of Extension. Many extension agents are actively involved in on-farm trials, although not necessarily as part of a complete farming systems approach. Thus, the institution will be able to draw on past experience to manage the program. Furthermore, all personnel intensively involved in the program will now be administratively responsible to a single individual, both the agents and staff of the Live Oak AREC.

Nonetheless, problems may arise. We have not been able to solve the problem of providing personnel new to the project with sufficient training at Florida. New agents, in particular, are already faced with a fairly

lengthy training program when they come into Extension. Adding the training requirements for farming systems to this commitment has not been easy. This leads to a lack of understanding of the methodology and resulting disorientation in regard to project goals and objectives. Personnel turnover, always a problem for Extension, has also been a source of difficulty in the multi-county agent positions.

THE HONDURAN CASE

A farming systems approach was first utilized at the Pan American School of Agriculture in its Integrated Pest Management (IPM) Program, which was initiated in 1982. In 1985, a more all-inclusive program was initiated with funding provided by the Kellogg Foundation. Unlike the IPM program, the Rural Development Program was not limited to problems associated with pest management.

Zamorano is a private educational institution. It offers three- and four-year degrees in agricultural science to students from Central and South America and the Caribbean. Its research mandate is limited, but in recent years a greater emphasis has been placed on research, and many faculty positions have been upgraded from the B.S. level to the M.S. or Ph. D. level. The overwhelming emphasis of the institution, however, is on teaching. A strongly applied approach to learning is utilized in which students spend about 20 hours per week actually involved in large-scale field production.

A very different organizational structure was utilized for the farming systems program at Zamorano. Essentially, a separate department was established-the Center for Rural Development. The Center assumed responsibility for teaching extension and farming systems methodologies to students at the school, providing non-resident training for technicians (primarily in a short-course format) and delivery of technical assistance to small farmers, utilizing a farming system approach. While the Center retains formal affiliation with the Agronomy Department, the size of the budget for the Center, its high level of autonomy and the establishment of a separate physical plant all produced a de facto department status, with the coordinator reporting directly to the Director of the school.

Initial organizational integration was both more rapid and more easily accomplished at Zamorano than at the University of Florida. As a small institution with flexible organizational structure, "fitting" the farming systems program to the existent structure was a relatively easy task. The Center is staffed by a coordinator, an assistant coordinator and a number of field technicians. Lines of authority are relatively clearly defined, and problems of communication within the institution are minimal. Figure 5 shows the organizational structure adopted at Zamorano.

LONG-TERM IMPLICATIONS

The approach taken at Zamorano represents in many ways a diametrically opposite approach to that taken at Florida. At the University of Florida, the farming systems approach has been incorporated into a well-established and relatively inflexible institutional structure. The process has been a slow one and one that has required extensive discussion and repeated alteration. The approach has been "made to fit" a pre-existent set of organizational conditions.

At Zamorano, on the other hand, the approach is being incorporated into a relatively fluid and somewhat undefined organizational structure, one that is still in an intense process of growth and evolution. The process is relatively rapid, is not accompanied by extensive discussion of institutional problems and has not required significant re-organization. Incorporation of the farming systems approach has not required great institutional change on the part of the school nor has it been necessary for the farming systems program to cope with problems of welding traditional pre-defined professional positions into an organizational structure appropriate for conducting farming systems research and extension.

Very important long-term implications arise out of the very different nature of the process of institutionalization for the two programs. An examination of the process of institutionalization from the point of view of the four criteria defined earlier reveals some of those implications.

Reward Systems

At Florida, professionals involved in the farming systems program and administrators have been faced with re-defining reward systems within the institution. This was very clearly manifested, for example, in the job description and performance evaluations of the multi-county agent positions. The multi-county agent in the farming systems program is highly involved in applied research, close contact with a limited number of farmers

and developing and testing solutions for farmers. Traditional job descriptions for agents call for much greater attention to dissemination of information and much wider clientele contact. The institution has been able to successfully meet this challenge on a de facto basis but has never satisfactorily solved the problem in the sense of developing well-tested, commonly agreed upon definitions of satisfactory job performance.

This problem does not arise when the approach used at Zamorano is adopted. Given the highly autonomous nature of the program, its internal coherence and its limited interaction with traditional programs at the school, reward systems can be defined within the program. Relatively little attention can be paid to traditional reward systems at the institution. Further, reward systems in general at a relatively young and evolving institution are less well established than at an institution such as the University of Florida, lending even greater flexibility.

In the longer term, however, this does not necessarily imply that reward systems will be more meaningfully altered at Zamorano. Because the institution is not confronted with basic challenges to its "normal" reward mechanisms and paths of upward mobility within the system, the incorporation of a farming systems program does not produce the healthy, if sometimes uncomfortable, discussion that occurs when more established institutions are faced with changing professional roles. The impact that a changed system of rewards, operating in relative isolation from the other departments of the institution, will have on long-term perceptions of appropriate professional activities and rewards at Zamorano is unclear. Even if the newer definitions of professional activities are accepted within the Center and award systems used there are perceived as appropriate to that department, this may have no effect on the more general reward system operative at Zamorano.

At the same time, the University of Florida has not had notable success in formalizing changed perceptions of reward either. Rather, rewards have been adjusted on an individual basis. While extensive discussion of this problem has occurred, many would probably argue that no changes have occurred or are needed.

On the other hand, both institutions have been able to provide for upward mobility of professionals involved in farming systems programs. The latest changes at Florida, in particular, open the way for individuals in Extension who wish to work in a farming systems program to move forward in their profession. At EAP, this problem simply never existed.

Organizational Structure

Here, too, the University of Florida has faced challenges in incorporating the farming systems approach into its traditional structure. The several changes in organizational format that have occurred all represent attempts to find the most effective manner of incorporating the farming systems program into a system that has a long organizational history and well established structures. None of the solutions that have been posed necessarily represents the ideal. More important than finding the "right" structure, however, has been the process of integration that has occurred. Comparison of Fig. 1 and 4 will show that the farming systems program at Florida has evolved from a classic "pilot project" structure in which the program was divorced from normal organizational structures into a structure in which the program has been incorporated into the institution's traditional structures, both modifying the structures and being modified by the structures in the process.

Again, this problem was never seriously encountered at Zamorano. The fluid nature of organizational structure at the school played a strong role; systems became part of a rapidly evolving and changing organizational format. Incorporation, therefore, never challenged traditional structures. On the other hand, the program at Zamorano remains in a "pilot project" status to a much larger degree than the Florida program since it has developed few interconnections with existent administrative units and structures in the institution.

The most recent changes at Florida represent a fairly extensive restructuring of the existent system. Placing management of the research station under Extension and thus drawing together all of the farming systems "employees" into a single unit may provide an important organizational model for other Florida programs, or even other farming systems programs in Florida, in the future. Thus, important structural changes could arise from this innovation.

At EAP, the "autonomy" of the program has been maintained and will probably continue into the future. The flexibility in organizational structure has definitely minimized problems associated with initiating the program. Again, however, the long-term impact on the entire institution is unclear. If the Center for Rural Development can develop close working ties with other administrative units, this organizational structure may be a very stable one and one that permits good interchange with the other departments of the school. If autonomy leads to isolation and lack of interaction, both the longevity of the program (especially once outside funds are withdrawn) and the ability of the program to have an impact on other programs will be highly limited.

Funding

Securing stable funding is a classic problem for all programs that begin as test or pilot programs and particularly for those that are initiated with outside funding. This was the case both at the University of Florida and at Zamorano. At Florida, the change from "outside funding" to "internal funding" status was a painful one. It required cutbacks in project activities, elimination of personnel and overall rationalization of project planning. In Florida, a stable funding base for the farming systems program has been established, which has permitted longer-term planning and has encouraged participation in the program on the part of the established faculty members.

The situation that will be encountered at Zamorano is a unique one. As a private institution, all activities at the school must ultimately "pay their own way." Whether this can be accomplished for the farming systems program is unclear. Initiation of training activities, as a source of revenue for the Center for Rural Development, represents the school's attempt to meet this challenge. These activities were, fortunately, initiated relatively early in the program's life, thus providing some leeway for developing a stable funding base before outside funds are eliminated.

The degree to which funding for the fanning systems program is internalized at EAP will be an important indicator of the program's overall effect on the institution. The institution has no formal responsibility for providing technical assistance to small farmers in Honduras. It has taken on this task as a result of (1) a perceived need to increase the school's relevance to Honduras and decrease its isolation in the country; (2) the fortunate opportunity to gain funds to use in this effort; and (3) a belief on the part of some that students should receive increased training in production practices appropriate for small farms (training now is heavily oriented to large-scale commercial production). If these activities persist once outside funding is withdrawn, this will indicate that the program has in fact helped change the focus of the institution.

Commonality of Objectives

Evaluating commonality of objectives is an extremely difficult task and subject to a great deal of subjectivity. Perhaps the best measure is administrative support for a program. Farming systems personnel, faculty and administration at the University of Florida have engaged in a long and on-going discussion of the goals, objectives and methods of the farming systems program. Over time, different specific goals have been identified, and methods have varied. In its inception, for example, the program utilized a "pure" farming systems approach, concentrating heavily on on-farm testing. Later, dissemination of information was given higher priority. Yet later, research was concentrated much more heavily on-station. It seems unclear whether there has existed or does exist within the Florida system a general agreement about the aims and methods of the program even though consistent administrative support for the program has been forthcoming.

At Zamorano, this kind of discussion has been limited largely to the faculty and personnel immediately involved in the program. This is no doubt partly a result of the relative isolation and/or autonomy of the program, partly a result of the generally low level of programmatic discussion at the institution and partly a result of the fact that the program does not threaten or impinge upon the institution's traditional ways of functioning. Again, consistent administrative support has been exhibited.

In both cases, it seems clear that agreement has not been achieved. This would indicate, perhaps, that arriving at such agreement is the most difficult task involved in institutionalization. It may also indicate that the discussion itself is of as great importance as arriving at firm conclusions. Particularly, maintaining lines of communication and flexibility of attitude become very important. Farming systems practitioners must remain open and willing to realize that program goals and objectives, as well as methods, must be adjusted to the institutional environment within which the program functions.

CONCLUSIONS

The term *institutionalization* should be operationally defined. It concretely implies that at least four processes have occurred or are occurring. First, the institution must be capable of providing for appropriate rewards for farming systems practitioners. Second, funding must be stable. Third, organizational structure must be adjusted so that the farming systems approach can be incorporated into the existent form. Fourth, there must be some degree of general organization-wide agreement on the goals, objectives and methods of the program, with appropriate administrative support.

Too often, new concepts for agricultural development are put into place at the cost of loss of continuity with previous programs and institutions. A close examination of international development efforts over the last 20

or 30 years will reveal a great number of instances in which entire organizations were abandoned and others reared in their place in order to facilitate the implementation of a new approach, such as farming systems.

This need not occur. Both in Florida and at Zamorano, the farming systems approach has been adapted to and has adapted existent organizations to achieve program goals. The process is a slow one, but it does provide for continuity. This approach is preferable to constructing entirely new organizations for two reasons. Adaptation to and of existent organizations allows for the development of an "organizational memory." It permits both organizations and individuals within them to incorporate what they have learned previously and apply it to the problem of utilizing a new approach. It also helps ensure that institutionalization will occur in a meaningful sense, one that will permit programs to continue beyond the short lifetime of most outside funding.

While very different approaches were used in Florida and Honduras, both cases show that it has been possible to incorporate a farming systems approach into an existent organization. In both cases, the approach had to be altered to "fit" within those institutions. Loss of methodological purity, however, was offset by the opportunity to impact the overall structure, ideology and methods of long-standing institutions.

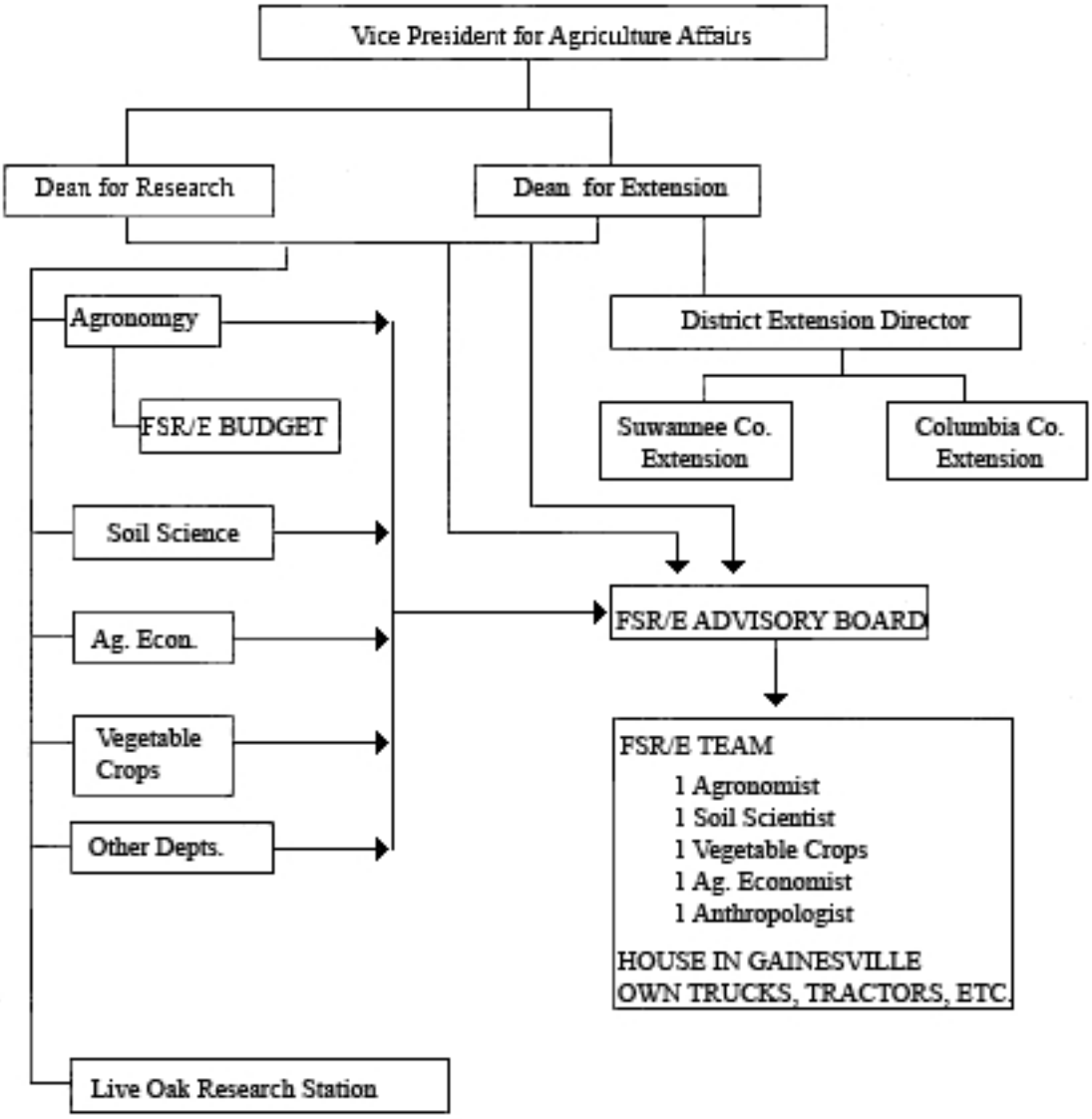

Fig. 1. Stage 1-team based in Gainesville.

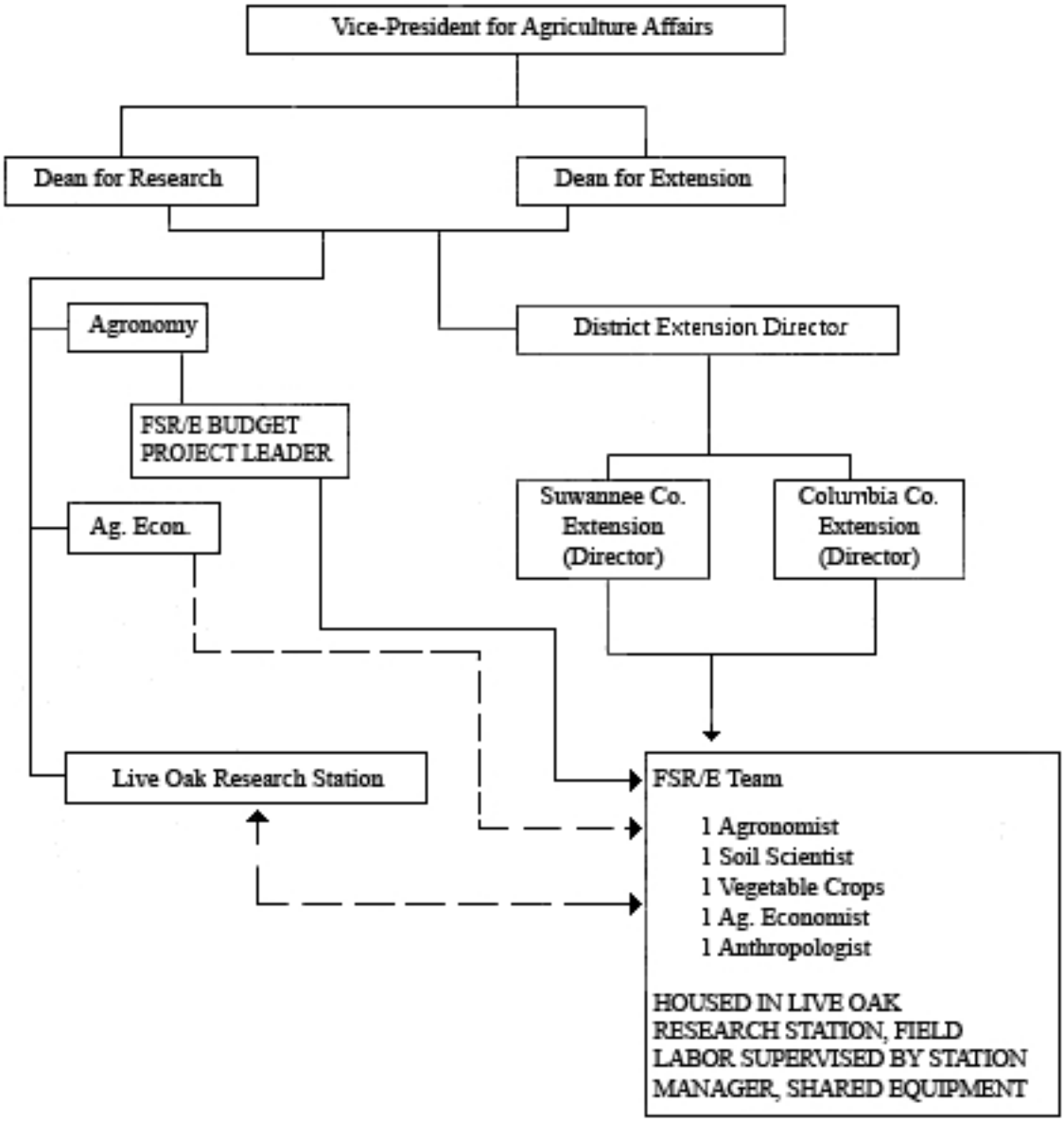

Fig. 2. Stage 2-the move to Live Oak.

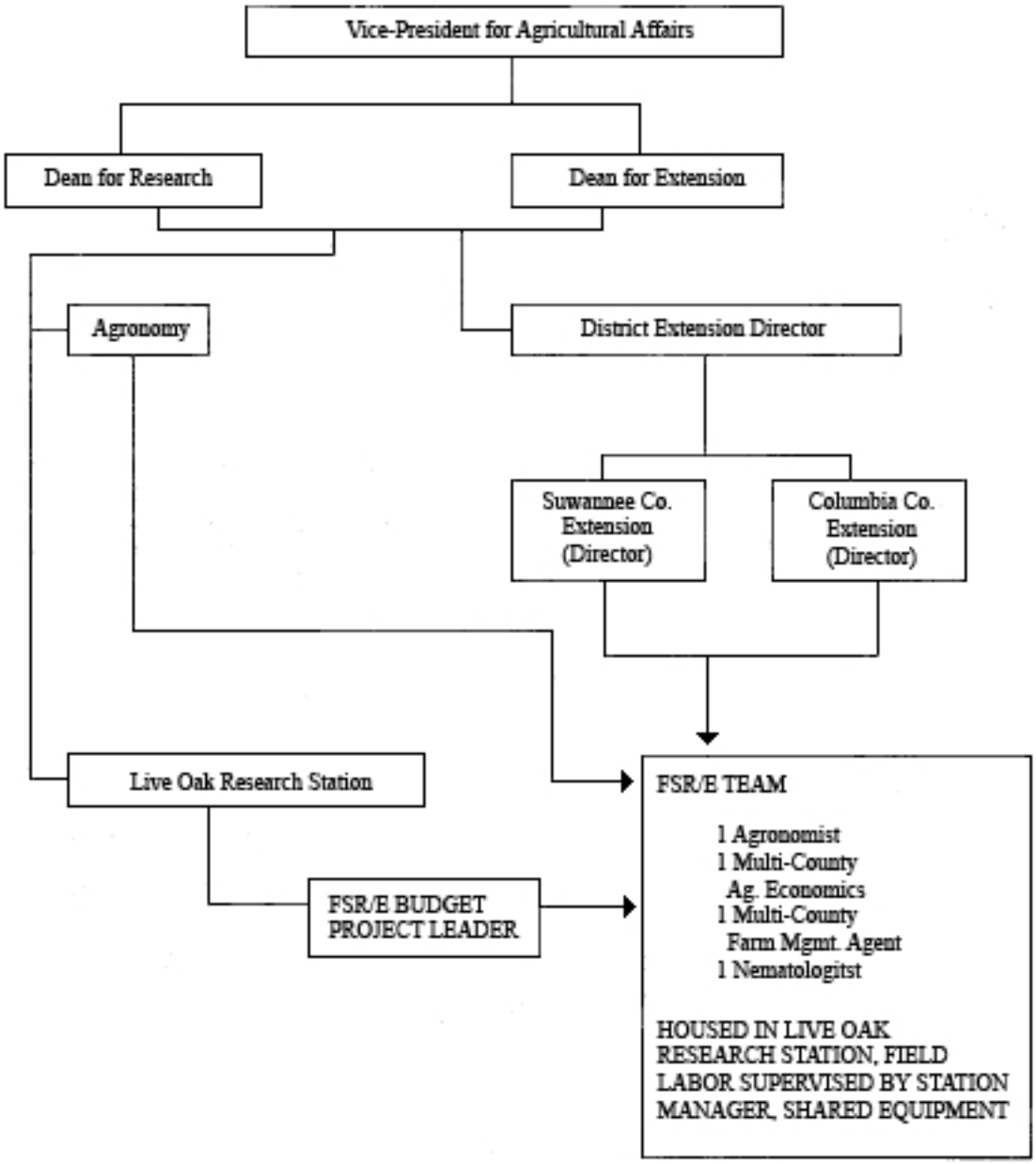

Fig. 3. Stage 3-management of project in Live Oak.

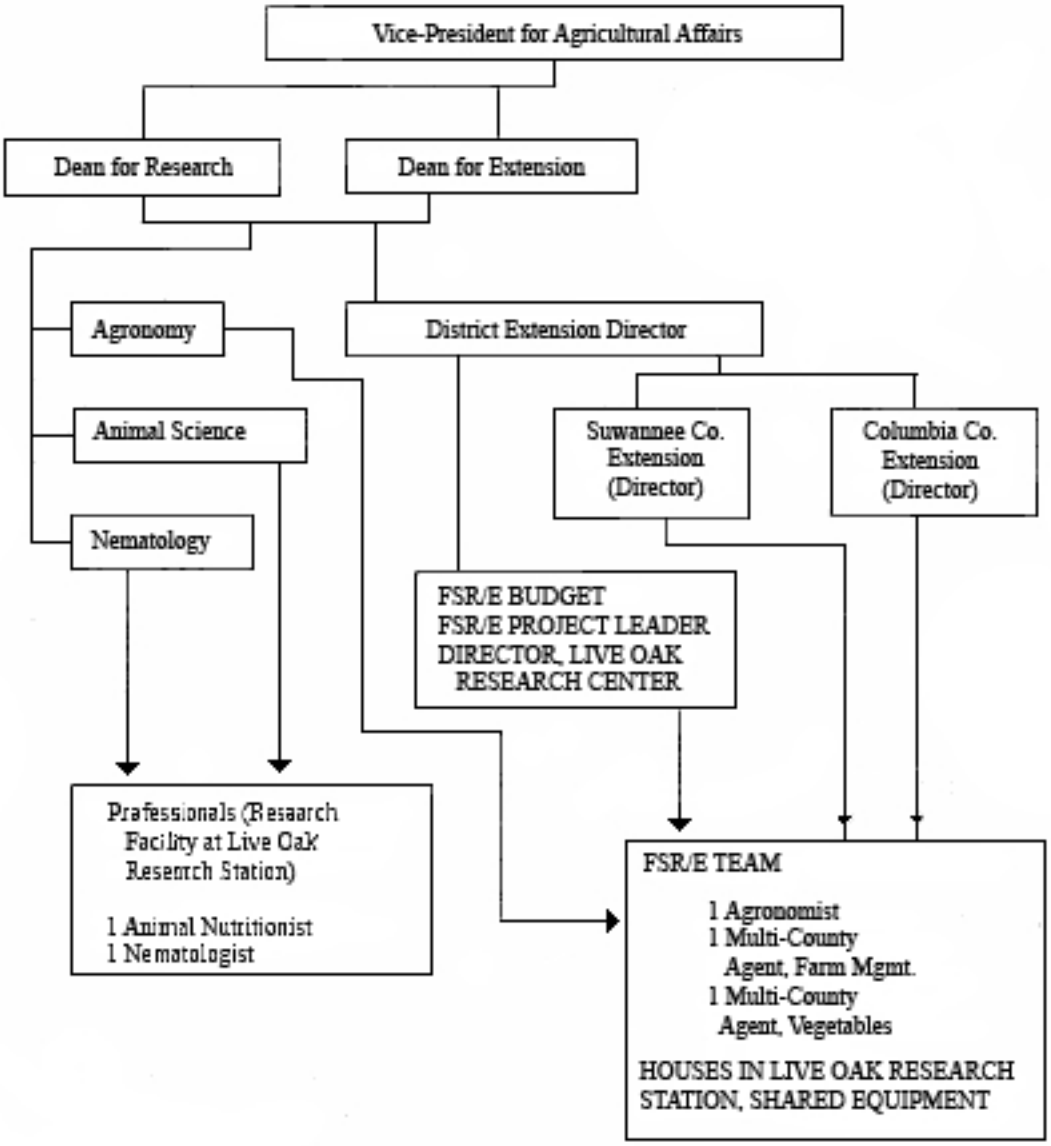

Fig. Stage 4-the final fit?

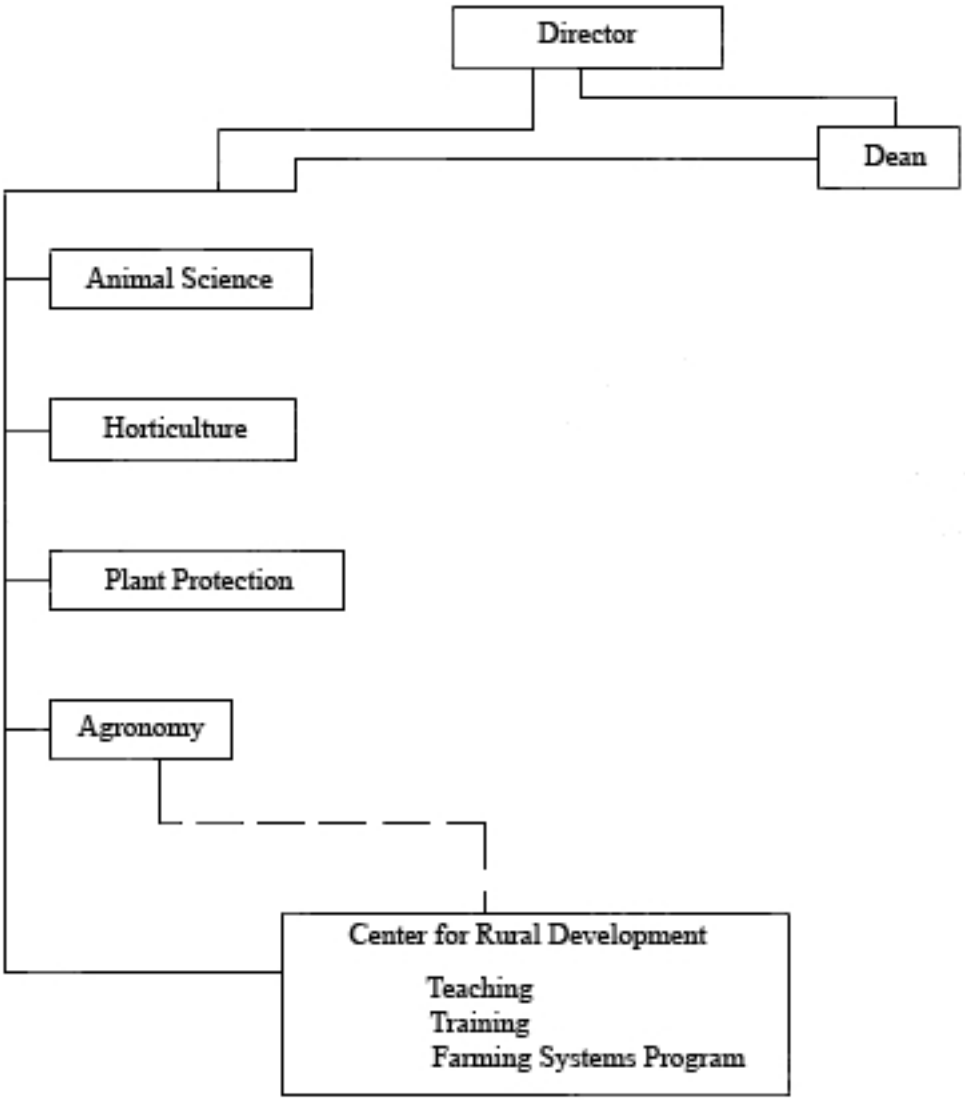

Fig. 5. Organization of farming systems at Zamorano

Global Papers:

Methodologies for Assessing the Impact of FSR/E

ASSESSING THE INSTITUTIONAL IMPACT OF ON-FARM CLIENT-ORIENTED RESEARCH PROGRAMS: LESSONS FROM A NINE-COUNTRY STUDY

Deborah Merrill-Sands[1]

ACKNOWLEDGMENTS

This analysis draws heavily on the nine case studies, listed in the references, produced as part of ISNAR's study on the organization and management on on-farm client-oriented research (OFCOR) in national agricultural research systems. I am indebted to the authors of these case studies for their hard work, the high quality of their research and the insightfulness of their analyses. The paper also reflects many of the ideas of my colleagues in the study who participated in developing the study's methodology and in carrying out aspects of the comparative analysis across the cases: S. Biggs, P. Ewell, J. McAllister, E. Moscardi and S. Poats. I, however, remain solely responsible for any errors or misinterpretations of data and information.

INTRODUCTION

The impact of Farming Systems Research (FSR) can be registered in two principal ways:

1) impact on production in the field in terms of the extent to which technologies and recommendations developed by FSR are adopted by extension and farmers; and
2) institutional impact in terms of the extent to which FSR has improved research systems' capacities to meet the needs of their clients more effectively and efficiently.

This paper focuses on assessment of institutional impact, drawing on the experiences and findings of a nine-country study carried out on the institutionalization and organization and management of on-farm client-oriented research (OFCOR) in developing country national agricultural research systems (NARS). The paper gives an overview of the study; highlights aspects of the study's methodology that are particularly relevant to assessing institutional impact; and reviews the study's major findings with respect to institutional impact of OFCOR efforts in three key areas: integrating on-farm and experiment station research, strengthening the link between research and resource-poor farmers and developing and sustaining an interdisciplinary systems perspective within research.

ISNAR Study on Organization and Management of On-Farm Client-Oriented Research

In 1986 the International Service for National Agricultural Research (ISNAR) initiated a major study on the organization and management of OFCOR in NARS. The study was initiated in response to requests from NARS leaders for advice in this area and was carried out with the support of the Government of Italy and the Rockefeller Foundation. The objective of the study was to analyze the critical research policy, organizational and managerial factors that affect national agricultural research institutes' capacities to successfully integrate and sustain OFCOR programs as stable and productive components of their research processes.

The study has been a major research effort at ISNAR, spanning three years, covering nine countries and involving approximately 30 scientists-both from within and outside of ISNAR-as researchers and advisors. We are now in the final stages of the analysis and write-up of research results. So far, four of the study's expected 17 case study reports and research papers have been published.

What is OFCOR? On-farm client-oriented research (OFCOR), which complements and depends upon experiment station research, involves a client-oriented philosophy, a specific approach to research, a set of methods integrating trials and formal and informal surveys and a variety of farm-level activities that range from

[1] International Service for National Agricultural Research (ISNAR).

the diagnosis and ranking of problems, through the design, development, adaptation and evaluation of appropriate technologies to solve them. As the principal clients of research, farmers are actively involved at various stages in the research process. We have used the term OFCOR rather than Farming Systems Research (FSR) because the latter has come to have a wide range of meanings for different people or schools of thought (Merrill-Sands, 1986). OFCOR corresponds to the type of FSR that has been called on-farm adaptive research or farming systems adaptive research (Byerlee et al., 1982; Gilbert et al., 1980; Norman, 1980, 1982); it is not equivalent to longer-term, more applied systems research or thematic research.[2]

Why is Organization and Management of OFCOR Important? Over the last 15 years, many NARS have set up OFCOR programs of varying scope and intensity to strengthen the link between research and farmers-particularly resource-poor farmers. Yet, while significant attention and creative thought has been given to developing methods for OFCOR, provisions for fully integrating this approach as a productive and stable component of the research process have been inadequate, and the institutional challenge often underestimated. With the accumulation of experience, it is clear that NARS have confronted significant problems in implementing and effectively integrating OFCOR into their organizations. In many cases, OFCOR programs have become marginalized and have not had the intended impact on the research process.

Many of these implementation problems have resulted from the special and unfamiliar organizational and managerial requirements of OFCOR. Effectively integrating OFCOR within a research system implies forging a new research approach that complements and builds on existing research efforts. This is no small task. It involves establishing new communication links and cooperative efforts among researchers of diverse disciplines, as well as between researchers and field technicians, extension agents and farmers. It requires hiring new staff with the right skills or systematically training existing staff. It requires changes in research planning, programming, review and supervisory procedures. It creates increased demands for operational funds and logistical support for researchers working in the field, often far from headquarters or stations. And it often involves working with one or more donor agencies, which often have divergent priorities and distinct operational and funding procedures.

All of these requirements make the management of OFCOR more demanding than that of traditional experiment station research. If OFCOR is to be successful in assisting agricultural research institutes to respond to the needs of resource-poor clients more effectively and efficiently, these organizational and managerial problems have to be tackled directly and surmounted.

Our study has focused directly on these issues of implementation and institutionalization. The analysis is built around case studies of organization and management of OFCOR in nine developing-country NARS. The experiences of these diverse NARS are now being analyzed and synthesized in a series of comparative study papers that provide practical guidelines for research managers on organizational and managerial issues central to effectively integrating OFCOR within their research systems.

Assessing the Impact of FSR

What can be learned from the OFCOR study with respect to assessing the impact of FSR? As discussed earlier, the impact of FSR, or OFCOR, can be registered in terms of its impact on production (Martinez and Sain, 1984) or on the welfare of farm families (Anderson, 1985); but it can also be registered and in terms of its impact on research institutions and the research process (Bernsten, 1983; Hobgood et al., 1980). Assessing impact on production in terms of rates of adoption of new technologies and rates of increase in productivity or total production is the traditional area for evaluating research. This is the approach for assessing FSR commonly put forth by donor agencies. Methods for this type of evaluation are available, and literature on this topic is extensive (McLean, 1988; Norton and Davis, 1981; Schuh and Tollini, 1978). Assessment of institutional impact, however, has received considerably less attention. In this paper, I concentrate on institutional impact because it is an important, yet often neglected, area for assessing the impact of FSR and because it is the area in which the methodology and findings of the OFCOR study can make the greatest contribution.

Assessing Institutional Impact. Why is institutional impact a legitimate area for assessing FSR's impact? FSR is designed to perform numerous functions within the research process. In addition to seeking niches for existing technologies and adapting them to particular agroecological and socioeconomic conditions, FSR has the less tangible function and longer-term objective of helping to rationalize priorities so that research systems are

[2]We use the CGIAR (1981) definitions of applied and adaptive research:
- applied research is that designing to create new technology,
- adaptive research is that designed to adjust technology to the specific needs of a particular set of environmental conditions.

efficient and effective in addressing their client's priority problems and needs. When operating successfully, FSR systematically identifies and defines client groups, diagnoses priority constraints within their farming systems and feeds this information into the priority-setting and planning processes of the research system. As concluded in the 1986 West African Farming Systems Research Network Workshop, it is essential that the performance of *all* of these research functions be examined when assessing impact of FSR, not just the extent to which OFCOR has gotten technology out to farmers (Merrill-Sands, 1988a).

How does one assess impact? Both impact on production and impact on the research process are important and relevant areas for assessing the impact of FSR programs. The methods and analytic procedures required, as well as the types of problems encountered in evaluating the two kinds of impact, are, however, very different.

Assessing impact on production in the field is complex due to the number of intervening institutions and policies that affect technology dissemination and adoption (Anderson, 1985; Horton, 1986: McLean, 1988; Schuh and Tollini, 1978). The success of research in getting technologies to farmers depends, to a significant degree, on effective functioning of other components in the technology generation and transfer process. Moreover, the process of technology generation, and even adaptation, especially in the more complex agroecological regions, takes considerable time. Impact on production is only applicable to the evaluation of more mature research programs. [3] These two problems of the time frame and of the intervening institutions make evaluation of research in terms of impact on production a very complicated exercise.

The distinct advantage of assessing institutional impact of FSR is that analysis is confined to the research system itself. Moreover, it is more appropriate for assessing younger FSR programs that have not had sufficient time to complete the process of technology generation or adaptation but that have had time to generate intermediate products designed to improve the relevance to specific clients groups of research as a whole. Such intermediate products include characterization of client groups and farming systems, definition and prioritization of research problems and design of potential solutions to identified problems drawing on the scientific knowledge and technologies available within the research system. Through these research activities, FSR strives to ensure the relevance of research to clients' needs. It is these processes and products that should be assessed when looking at institutional impact.

Institutional impact, nevertheless, is also difficult to evaluate. Many of the criteria for evaluation cannot be measured in quantitative terms. Assessing influence on research agendas of commodity or disciplinary research programs, for example, is not comparable to counting the number of adopters or measuring the percentage of land devoted to new varieties. Questions that have to be addressed when assessing institutional impact of FSR are as follows:

> Has FSR been successful in building a stronger link between the research system and its clients, the farmers?
>
> Is FSR effectively mobilizing the research systems' scientific knowledge to address the priority needs of designated client groups?
>
> Is farm-level information generated by FSR influencing priorities and research plans in other programs?
>
> Is FSR viewed within the research system as a complementary research approach that can enhance the productivity and relevance of the research process as a whole?
>
> Has effective collaboration developed between scientists working in FSR and experiment station research so that each provides the required services and products to the other?
>
> Has FSR been successful in developing an interdisciplinary systems perspective within research?

Collecting evidence, qualitative and quantitative, required to answer these kinds of questions requires a methodology that ensures systematic and balanced consideration of all relevant factors.

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[3] McLean (1988) states that impact evaluations of research have a time frame of ten or more years after research results have been released.

Relevance of ISNAR's OFCOR Study. The findings of the OFCOR study-which analyzes issues in the implementation and institutionalization of OFCOR research functions in NARS--can contribute substantially to our understanding of the relevant issues and considerations for assessing FSR's institutional impact in national agricultural research systems. Our analytic approach and methodology, in turn, can contribute ideas useful for developing relevant procedures for assessing institutional impact.

THE ANALYTIC APPROACH AND METHODOLOGY OF THE OFCOR STUDY

Two aspects of the OFCOR study methodology are particularly relevant to procedures for assessing institutional impact--the case study approach and the analysis of performance of specific research functions. It must be emphasized, however, that in the OFCOR study the assessment of institutional impact was a means to an end. We assessed the performance of OFCOR's various research functions in the case study NARS in order to understand better the research policy, organizational and managerial factors influencing functional performance. The product of our study was never intended as an evaluation of the OFCOR programs studied; the product is guidelines for research managers on effectively organizing and managing OFCOR programs. Nevertheless, the study can serve as a basis of ideas and suggestions for approaches and methods for assessing FSR's institutional impact.

Methodology of the OFCOR Study. Selected Aspects

Case Study Approach. Any broad-based assessment of the impact of FSR/E will most likely have to rely on developing a series of case studies of FSR/E programs and projects. The OFCOR study's experience in using the case study approach can provide some valuable insights for its effective application in assessing institutional impact.

Since our approach has been to learn from the experiences of research managers in NARS, we based our analysis on case studies of OFCOR programs in nine NARS that have had sufficient time to experiment with and develop diverse organizational arrangements and management systems for implementing OFCOR. [4] Each case is a comprehensive analysis developed by a team of national researchers with personal experience in the individual OFCOR programs. The case studies are stand-alone products, but they also form the basis of our comparative analysis across case studies on our principal analytic themes.

Two important methodological concerns are obtained when using the case study method: 1) criteria for selecting cases and 2) ensuring comparability among cases. Both pertain to the ability to make defensible generalizations on the basis of specific, individual experiences.

With respect to the selection of cases, the basic issue is, do you select cases that are representative of the known variability in a larger population, or do you purposely select cases that allow you to examine particular issues or types of situations in depth. Obviously the choice of approach will depend on the objectives of the research. In either case, however, the criteria for selection have to be made explicit.

In the OFCOR study, developing a representative sample based on organizational types, for example, was not possible. We faced the several constraints, many of which would also apply to a broad-based assessment of the impact of FSR: 1) the population from which the sample was to be taken could not be clearly defined; 2) the large number of parameters relevant to the study mitigated against a systematic classification of cases by types; 3) the number of NARS with accumulated experience in OFCOR was limited; and 4) the number of case studies feasible given our resources was limited. Consequently, we used a purposive selection process using criteria that reflected our research objectives. We needed cases that were sufficiently similar to permit systematic comparative analysis but that were also sufficiently diverse to provide a broad range of institutional experiences.

Several explicit criteria guided our selection of NARS.

1. It was essential that OFCOR be formally organized within the NARS, i.e. that a research program, department or station be given a mandate for OFCOR. This is, itself, an indicator of institutionalization and senior management commitment to OFCOR. We did not consider situations in which OFCOR was implemented through an externally funded special project that operated independently or was only "appended" to the NARS.

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[4] For a list of the case studies, see Part I of the References.

2. The OFCOR effort had to be performing, or at least be designed to be performing, the range of research functions we had identified as basic to OFCOR (see below). This was essential for comparability across cases. We did not, for example, look at OFCOR efforts that performed only technology verification or that had limited their activities to in-depth descriptions of farming systems.
3. It was crucial to our research objective that the NARS be involved with OFCOR for sufficient time to gain useful management experience (minimum of five years of field research).
4. The NARS had to be diverse with respect to their organization and structure and their resource endowments and research capacities.
5. The sample had to reflect a balanced distribution among regions because the organizational structures of the NARS as well as the traditions of OFCOR vary significantly across regions (Trigo, 1986).

The universe of potentially relevant cases, as determined by these criteria, was defined drawing on the literature and extensive consultations with NARS research managers and FSR practitioners and advisors. In making the final selection of cases, we applied two additional operational criteria relevant to the execution of the research itself. Because we were examining in depth the effectiveness of various institutional arrangements for OFCOR and diverse management practices, we needed to work with NARS where 1) senior managers were sufficiently interested in the study to permit the required freedom in the investigation and presentation of results, and where 2) competent national researchers who were familiar with the histories and details of the OFCOR programs were available to participate in the study.

Since our intention was to build up a practical body of experience on organizing and managing OFCOR, we emphasized depth of analysis over breadth of coverage and limited our cases to nine countries that, by region, are as follows: in Latin America, Ecuador, Guatemala, Panama; in Africa, Senegal, Zambia, Zimbabwe; and in Asia, Bangladesh, Indonesia, Nepal. Annex 1 gives the collaborating institution(s) in each country and the specific OFCOR efforts studied. Annex 2 provides key descriptive indicators of the individual cases.

To be able to generalize beyond the realm of anecdotes and to extract useful principles and management guidelines for research managers, we needed to ensure comparability of analysis across cases. To this end, ISNAR developed a common analytic framework to be applied in all case studies. The analytic framework comprised two parts: 1) detailed guidelines for the structure and content of the case studies, indicating the analytic issues to be addressed and the types of data and evidence to be collected and presented; and 2) a specific set of analytic methods. Case study researchers tested the guidelines in the field and adapted them to their specific situations. We then all came together in a workshop to review and revise the guidelines and to ensure that all case study research teams were proceeding with a common analytic approach and a common set of priorities for the issues to be examined in the cases.

A similar operational approach of developing a common analytic framework and methodology, testing it in the field and bringing researchers together to review and adjust the framework after some field testing would be important in any broad-based assessment of FSR/E impact, especially if several distinct teams are charged with carrying out the evaluations.

Assessment of Functional Performance. A major part of the OFCOR study is the analysis of OFCOR programs in terms of the functions OFCOR can perform within the larger research process. Our objective was to assess the performance of these identified functions across the case studies in order to determine how research policy, organizational and managerial factors affected their performance. Since this type of functional analysis would be a useful methodology for assessing institutional impact of FSR/E, I outline our approach in some detail.

Through extensive discussions with OFCOR practitioners and a review of the literature, we identified a core set of research functions characteristic of the majority of OFCOR efforts. Our management guidelines are organized around this functional analysis. The functions are as follows:

1) to support within research a problem-solving approach, which is fundamentally oriented toward farmers as the primary clients of research;
2) to contribute to the application of an interdisciplinary systems perspective within research;
3) to characterize major farming systems and client groups, using agroecological and socioeconomic criteria, in order to diagnose priority production problems as well as identify key opportunities for research with the objective of improving the productivity and/or stability of those systems;
4) to adapt existing technologies and/or contribute to the development of alternative technologies for targeted groups of farmers sharing common production problems by conducting experiments under farmers' conditions;

5) to promote farmer participation in research as collaborators, experimenters, testers and evaluators of alternative technologies;
6) to provide feedback to the research priority-setting, planning and programming process so that experiment station and on-farm research are integrated into a coherent program focused on farmer' needs;
7) to promote collaboration with extension and development agencies in order to improve efficiency of the technology generation and diffusion processes.

To guide the systematic assessment of performance of the functions and ensure comparability across the diverse case study situations, we developed a set of indicators of performance for each of the seven functions (Merrill-Sands, 1988b). The indicators provided a comprehensive and structured set of considerations to guide case study researchers in collecting data and mustering evidence required to systematically assess the performance of functions within their respective systems. Some indicators lend themselves to quantitative analysis, while most are more qualitative in nature.

It should be stressed that the indicators were not designed as explicit evaluation criteria; they are neither fully discrete nor weighted, and no single indicator alone is adequate as a basis for assessing performance. The indicators are complementary and are designed to be used together to guide inferred judgment and provide the basis for a balanced appraisal of functional performance. As an example, the indicators developed for assessing the performance of OFCOR's feedback function are provided in Annex 3.[5] Specific suggestions for data collection methods supplemented each set of indicators.

SELECTIVE REVIEW OF FINDINGS ON THE INSTITUTIONAL IMPACT OF OFCOR IN NINE CASE STUDY NARS

In this section, the findings emerging from the comparative analysis of the nine OFCOR case studies are reviewed with respect to three themes central to assessing institutional impact:

1) the integration of OFCOR and experiment station research;
2) the involvement of farmers in the research process;
3) the development of an interdisciplinary perspective within research.

Integrating OFCOR and Experiment Station Research

Designed to complement--and reliant upon--on-station research (OSR), OFCOR's success, in terms of realizing its potential to improve a research system's capacity to respond to the priority needs of its clients, depends largely upon its effective integration with commodity and discipline research carried out on experiment stations. Without such integration, OFCOR cannot survive as a stable and productive component of the research system (Baker and Norman, 1988; Biggs and Gibbon, 1984; Collinson, 1987; Fresco, 1984; Gilbert et al., 1980; Norman, 1983).

OFCOR-OSR integration is, therefore, a critical area for assessing institutional impact. Here we need to look at the degree to which farm-level information generated by OFCOR has influenced OSR research priorities and research agendas as well as the degree to which OFCOR has been successful in mobilizing knowledge and technologies from experiment station research to address the needs of identified client groups.

Comparative analysis of the cases revealed that, in practice, strong OFCOR-OSR integration is difficult to achieve and sustain over time. Research managers have run into significant institutional and logistical problems when trying to develop full and systematic collaboration among researchers working in OFCOR and OSR. Conflicts and misunderstandings were reported in the majority of cases. This is hardly surprising, for the very factors that make these OFCOR and OSR complementary research activities also create the potential for conflict.

The case studies revealed that basic disagreements about what constitutes good science and credible research have often divided OFCOR and OSR scientists. Conflicts typically stemmed from divergent ideas of the priority constraints to agricultural development and of the appropriate clients and products of research. Differences in research objectives, methods and modes of analysis further complicated cooperation. Such differences in goals and attitudes have led, in turn, to disputes over more concrete issues such as allocations of funds and

[5] See "Methodology Modules for Institutional Analysis: ISNAR Study on the Organization and Management of On-Farm Client-Oriented Research in NARS, " Staff Note No. 88-12, The Hague: ISNAR (1988).

staff among OFCOR and OSR programs, over priorities in planning and annual programming of research or over the validity and interpretation of results. The case study experiences show that staunch backing from senior research managers and their active and creative management are needed to develop and sustain effective and productive OFCOR-OSR integration (Merrill-Sands and McAllister, 1988).

The Nature of OFCOR-OSR Integration. OFCOR-OSR integration can best be understood by considering the complementary research functions that OFCOR and OSR perform, or can potentially perform, for each other in the research process. We have identified a cluster of five research functions that constitute the link between OFCOR and OSR. In any given research system, how these five basic linkage research functions are performed and the relative balance among them determines the nature of OFCOR-OSR integration and its relative strength.

OFCOR linkage research functions. OFCOR can perform a service function, an adaptive research function and a feedback function for OSR. OFCOR's service function, involving broad-scale on-farm screening, testing and evaluation of technologies developed on station, extends station-based research to the farm; a demonstration role is often an important secondary objective of the trials. The adaptive research function is the diagnosis of farm-level constraints and the adaptation of existing technology to a particular set of environmental conditions—agroecological or socioeconomic—through on-farm research. In the feedback function, relevant information from farming system descriptions, farm-level diagnosis or adaptive research is channeled into OSR priority-setting, planning and annual programming and review processes. The feedback function is aimed at assisting research programs to respond to the identified needs of their clients rather than to their own specific discipline-or commodity-determined interests.

OSR linkage research functions. OSR can perform an applied research and a support function for OFCOR. OSR's applied research function is the generation of technology components. OFCOR depends on strong, applied OSR programs for technological alternatives to screen, select and adapt to the specific needs and conditions of designated client groups. In the support function, commodity and disciplinary specialists provide advice and knowledge to OFCOR at all stages of the research process-diagnosis, design of technological solutions and interpretation of results. This function implies that station-based researchers have both the opportunity and the ability to keep abreast of relevant scientific advances in their areas of expertise. Such specialized disciplinary knowledge is the complement to OFCOR's specialized knowledge of farm-level circumstances and problems.

Assessment of OFCOR-OSR Integration in the Cases Studied. OFCOR-OSR integration is assessed in the OFCOR study by examining the relative performance of five linkage research functions. Our assessment, while based largely on the case studies' in-depth analyses of performance using the indicators of functional performance described above, also reflects a systematic comparative analysis across cases and the careful evaluation of evidence presented in the case studies.

Figure 1 summarizes our assessments of performance of the individual linkage research functions.[6] The comparative review shows that good progress has been made towards institutionalizing these functions. In the majority of cases, their performance was judged as moderate or strong. The findings also indicate, however, that there is no room for complacency. Even in these relatively mature OFCOR programs, in only a few cases was strong integration with effective performance of *all* linkage functions considered to have been fully institutionalized.

Issues in Institutionalization. Three general observations can be made concerning the relative performance of the linkage research functions and their degree of institutionalization in the cases studied:

1) The adaptive and applied research functions have been the most successfully implemented;
2) The service function, despite its being the traditional role of on-farm research, has varied markedly across the cases in relative importance and degree of implementation;
3) The feedback and support functions have been the least fully implemented.

The adaptive and applied research functions. The performance of these functions was judged to be moderate to strong in 90% of the OFCOR situations reviewed. In adaptive research, the agronomic component has been most vital; the social scientific component has been neither as widely implemented nor as successfully integrated (Ewell, 1988). In applied research the lack of technologies appropriate for the comparatively

[6] In total 13 linkage situations were analyzed because in four cases-Indonesia, Nepal, Senegal and Zimbabwe—distinct institutional arrangements within the NARS had created different types of OFCOR-OSR integration.

marginal environments typical of OFCOR's resource-poor clients and for the non-crop components of farming systems, such as livestock or agroforestry, hindered strong performance in some cases.

The experiences of the cases indicate that the adaptive and applied research functions, both of which relate to the flow of technologies through the research system, are easier to institutionalize than the support and feedback functions. The division of responsibilities between OFCOR and OSR can be made quite clear. Moreover, institutional changes to implement these functions are likely to be more modest. Mechanisms to encourage timely information exchange between OFCOR and OSR are needed, but major alterations either in the planning and programming of research or in scientists' responsibilities usually are not. The main source of potential conflict revolves around the wish of OFCOR researchers to control their own research agenda based on priorities determined through farm-level diagnosis rather than to serve simply as on-farm testers of technologies "pushed out" by OSR.

The service function. In 70% of the OFCOR situations, the performance of the service function was considered moderate to strong (Fig. 1). This function was generally viewed as the responsibility of OFCOR; its relative importance and degree of implementation, however, varied considerably across the cases reviewed. In cases in which, for example, specific departments had an exclusive mandate for on-farm research, the service function was dominant. In others in which station-based research programs carried out their own multi-locational testing, OFCOR's service function was of slight importance.

Since the service function is the traditional role of on-farm research, it is usually the easiest to establish, demanding minimal changes in organization and resource allocation. It can be arranged as an extension of existing research programs and be conducted by technicians or junior-level agronomists. Nevertheless, the experiences of the cases suggest that even such an essentially conservative division of responsibilities between OFCOR and OSR can result in conflict that inhibits effective integration. In several instances, OFCOR researchers found that as long as their evaluation of technologies was favorable, OSR commodity and discipline programs were supportive of their research. In the event that testing results were negative, however, OSR scientists challenged the scientific validity of OFCOR methods, the representativeness of farmers participating in trials and the reliability of their results.

The experiences of the case studies indicate that the danger inherent in overemphasizing OFCOR's service function is that OFCOR comes to be viewed as a mere extension, or handmaiden, of station-based research, or even to define its own research agenda.

The feedback and support functions. Of the five research functions, feedback and support were considered the least successfully implemented in the cases reviewed (Fig. 1). Their performance was considered moderate or strong in only slightly over half of the cases. These findings, especially in relation to relatively mature OFCOR efforts, are disturbing, for these two functions are essential to realizing the full potential that strong OFCOR-OSR integration has to offer for improving the capacity of research to respond to the needs of designated client groups.

Three principal sources of friction impeding the acceptance and development of the feedback and support functions were evident in the cases (Merrill-Sands and McAllister, 1988). First, because these functions involve influencing the research agenda of other scientists and scientific programs, they can provoke conflicts of interest, power and scientific judgment. Second, since both feedback and support functions depend on interaction among researchers and joint planning, they involve shifts in researchers' work programs, areas of responsibility and decision-making autonomy. This can create tensions and lead to resentment among scientists working in OSR and OFCOR. And, third, the kind of benefits accruing from the collaboration entailed in the feedback and support functions, which are somewhat intangible and realized in the long term, are often perceived as greater for the institution than for the individual researcher. In contrast the additional demands made on researchers' time and scarce resources, often perceived as personal costs, are concrete and immediate in nature.

It was very clear in the cases, furthermore, that if the feedback function is to be effectively performed, OFCOR must have scientific credibility within the research system. This requires that OFCOR scientists have research experience and degrees comparable to scientists working in OSR and that they can effectively communicate and defend the diverse kinds of information and data generated through on-farm research.

Achieving strong OFCOR-OSR integration, especially with respect to successful implementation of the feedback and support functions, poses a significant challenge to research managers. Research managers need to define respective OFCOR and OSR research objectives and functions explicitly. They must then organize channels for frequent and timely communication, promote incentives for collaboration, support the development of new research skills among their staff and allocate resources for collaborative activities and projects.

This requires a clear and focused management strategy that develops research policy support as well as organizational arrangements and managerial mechanisms for collaboration.[7]

Involving Farmers in the Research Process

Strengthening the involvement of farmers, particularly resource-poor farmers, in the research process has been a central objective and responsibility of OFCOR programs. OFCOR is designed to build a stronger link between research and farmers, its primary clients. The objective is to improve the effectiveness and efficiency of research by systematically incorporating the client's perspective. The relevant questions with respect to institutional impact of OFCOR, then, are as follows. How effective has OFCOR been in its designated role of bringing research and its clients closer together? Has it been successful in giving farmers a stronger voice-a means to influence the research process in terms of defining its agenda and evaluating its products?

The experiences of the cases indicate that OFCOR efforts have been generally successful in improving the understanding within the research system of clients' priority problems and needs. The OFCOR programs studied have identified specific client groups, defined and described their farming systems and diagnosed the key constraints and opportunities for research. They have encountered problems, however, in developing the active and sustained involvement of farmers throughout the research process. In most cases, farmers' participation was limited to certain set roles in the implementation and management of trials. In only a few situations were they involved in research management processes such as setting priorities, planning experiments or surveys, reviewing and interpreting results and evaluating technologies (Biggs, In press; Ewell, 1988).

Types of Farmer Participation. Three modes of farmer participation were found in the OFCOR situations reviewed:

1) contract mode;
2) consultative mode;
3) collaborative mode (Biggs, In press).[8]

In the contract mode, researchers interact with farmers in a very limited capacity in order to procure their land or services for on- farm research.

In consultative participation the relationship between researchers and farmers is analogous to a "doctor-patient" relationship. Researchers consult farmers, diagnose their problems, with varying degrees of input from the farmers, and try to find solutions. Farmers have a passive role. They are consulted as clients about their needs and priority problems and for their evaluations of the products of research, but they do not participate actively in the definition of research agendas or the design and development of technological solutions. Formal and informal surveys are the dominant method for capturing information about farmers, and OFCOR researchers are commonly charged with representing the farmers' point of view in the research planning and review process.

In collaborative participation scientists regard farmers as active partners in research. Interaction between researchers and farmers is continuous and more intensive than in the consultative mode. Through regular research meetings and informal consultation with researchers, farmers clarify the logic of both their current practices and their demand for new technology, as well as monitor the progress of on-going research and evaluate its results.

Slightly over half of the 25 discrete OFCOR programs and projects reviewed in the nine-country cases with respect to farmer participation relied on the consultative mode of farmer participation. This is not surprising, since standard Farming Systems Research and Cropping Systems Research methods have emphasized this mode of participation. Collaborative farmer participation, found in approximately a third of the programs, was most prevalent in those programs that required routine monitoring of data on farmers' circumstances, such as livestock and pest management research projects, or in programs undertaking research in complex and poorly understood agroecological zones.

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[7] Guidelines for designing such a management strategy are outlined in Merrill-Sands and McAllister (1988).

[8] This typology is similar to that developed by Ashby (1986). Biggs included a fourth mode of participation-the collegiate mode-in his typology, which, although it was not found in the cases reviewed, is increasingly reported in the literature. In this mode scientists from the formal research system identify, support and draw upon informal research being carried out by farmers on their own.

Problems in Institutionalization

Comparative analysis of the cases revealed three common and interrelated problems affecting OFCOR programs' ability to successfully perform their institutional role of strengthening the link between research and its principal clients, the farmers:

1) problems in sustaining farmer involvement throughout the research process;
2) problems in selecting farmer cooperators who are representative of identified client groups;
3) problems in systematically synthesizing and using information obtained from farmers.

Research managers will need to give attention to these problems if OFCOR is to perform its linkage function effectively and achieve the intended impact on the research process.

Sustaining farmer involvement. Many of the OFCOR programs studied have had difficulties systematically incorporating new information from farmers and farm-level research after the initial diagnostic stage. After the initial flush of creative energy enthusiasm, attention to effectively involving farmers in the research process tends to wane, and methods and procedures for eliciting information from farmers tend to become mechanistic.

Sustaining farmers' involvement in research is important if OFCOR is to function effectively as a link between research and its clients. Farmers can play an important role in monitoring research, ensuring that it remains focused on their priority problems and that the potential solutions being developed are appropriate and feasible for them to adopt. Periodic feedback from clients improves efficiency and effectiveness of research by helping scientists to identify earlier whether technologies they are developing are appropriate solutions to identified problems and to anticipate more readily second generation problems arising from the use of new technologies.

The tendency towards methodological stagnation observed in the cases raises concerns about the potential institutional impact of OFCOR efforts. As OFCOR programs lose vigor in generating farm-level information, which should, after all, be their area of expertise, their institutional status and ability to influence research agendas of other programs also declines.

Selecting representative farmers. Somewhat surprisingly, given the attention devoted to farmer selection in FSR methodologies and FSR literature, comparative analysis revealed that selecting representative farmers as cooperators has been a chronically weak area in the OFCOR situations studied. OFCOR researchers confront a constant tension in selecting farmers. On the one hand, they need farmers who are representative of an identified client group in order to ensure the utility their feedback. On the other hand, they need farmers who are good collaborators in order to ensure the quality of experimental research results.

In general the OFCOR programs studied had not given high priority to developing systematic and defensible procedures for selecting farmer cooperators. OFCOR programs had regularly developed formal criteria for selecting farmers but then often did not apply them systematically in the field when faced with difficult logistical problems of contacting farmers or urgencies in getting trials planted on time or results reported on schedule. Farmer selection has often been done on an ad hoc basis. Researchers simply accept the suggestions of extension agents, take volunteers at meetings or delegate selection of farmer collaborators to junior field staff with minimal guidance. OFCOR programs that had critically examined their selection procedures found that such ad hoc selection biases samples in favor of male, wealthy and politically active farmers (Kean and Singogo, 1988; Sopliz et al., in press; Sutherland, 1986). Such biases jeopardize the quality and relevance of the information being fed back into the research system as well as OFCOR's scientific credibility.

Synthesizing farm-level information. A primary function of OFCOR is to bring researchers and farmers into closer contact and promote the exchange of information and knowledge. Nevertheless, although OFCOR staffs frequent contact with farmers has clearly led to improved understanding of farmers' circumstances, problems and management practices, the experiences of the cases indicate that this knowledge has been difficult to synthesize into a form that can be communicated easily to other researchers. Recognizing this problem, many OFCOR programs have experimented with using diverse kinds of meetings with farmers as a means to concentrate and formalize the elicitation of information from farmers and its feedback to the research system. A second solution has been to systematically involve field staff, such as technicians and field assistants, who collect a lot of information through their regular and informal contacts with farmers, in research meetings to review OFCOR results and plan the trials and surveys for the following season.

Developing and Sustaining an Interdisciplinary Perspective

The development of an interdisciplinary perspective is a critical function of OFCOR. OFCOR's clients are small-farm households that operate complex production systems, involving a range of crops and animals, under diverse agroecological and socioeconomic conditions. The development of improved technology for these clients requires a systems perspective and a broader range of research activities than the conventional limits of any single discipline.

Strategies for Achieving Interdisciplinary Research. All of the programs reviewed in the study have put together interdisciplinary teams at least once for an initial diagnostic survey or priority-setting exercise. For on-going field research, however, quite different strategies for maintaining disciplinary breadth have been used. At one extreme, as in the Ecuadorian case, one or two agronomists with special training in on-farm research methods are responsible for OFCOR in an entire province. At the other extreme, as in Bangladesh and some projects in Indonesia, large field teams involving several disciplines and as many as 15 or 20 members are responsible for a broad range of on-farm research activities at specific field sites (see Annex 4 for disciplinary composition of field teams).

The approaches for developing an interdisciplinary perspective found in the cases can be categorized into three broad types (Ewell, 1988):

1. Reliance on researchers from a single technical discipline**.** In nearly half of the 21 individual OFCOR efforts reviewed in the nine countries studied, most of the field research has been carried out by "generalists" (Annex 4). These generalists are usually agronomists, or animal scientists in livestock projects, who have received additional training in designing and implementing formal and informal surveys and in simple techniques of economic evaluation such as partial budgeting. They are often less experienced, junior scientists who are backstopped, to varying degrees, by specialists in both the natural and social sciences located in experiment stations or central offices. This mode predominates in the Latin American cases studied.
2. The "minimal pair" of disciplines**.** In this strategy, found in approximately 15% of the programs studied, agronomists are teamed with agricultural economists in the field (Annex 4). These are generally more experienced scientists who, in some cases, operate quite independently from researchers in other programs.
3. Farming systems teams with a broader range of disciplines**.** Approximately a third of the OFCOR programs studied have mounted broader farming systems teams including specialists from such additional disciplines as animal science, forestry, nutrition, sociology and anthropology (Annex 4). In some cases, as in Senegal, these are permanent postings, and in others, such as in Indonesia and Bangladesh, disciplinary scientists are seconded from their home institutes or departments to participate for a fixed period of time in these Farming Systems Research teams.

Issues in Developing an Interdisciplinary Perspective. Interdisciplinary versus multidisciplinarv research. The experiences of the cases indicate that while OFCOR programs have been successful in developing multidisciplinary research, effective interdisciplinary research has been difficult to achieve (Ewell, 1988; Bingen and Poats, in preparation). By interdisciplinary research we mean that scientists from various disciplines are involved in a research program and that the effort is mutually planned, executed and evaluated (Bingen and Poats, in preparation). Even if appropriate specialists and sufficient resources are available-and they often are not—posting researchers from different disciplines to the same team or program certainly does not guarantee that they will work together productively. Without strong management, incentives for collaboration and opportunities to work together, scientists tend to retreat into their own disciplinary research agendas. Several cases reported situations in which members of a so-called "team" carried out entirely separate research programs following the conventions of their respective disciplines and then stapled the results together into a "joint report."

Lessons from the cases indicate three elements essential for achieving effective interdisciplinary research within OFCOR teams: 1) strong team leadership from a scientist with disciplinary breadth and solid field experience; 2) research management processes that bring the individual disciplinary scientists together to jointly review their research results and program the following season's work; 3) incentives to encourage scientists to continually re-adjust their research agendas in response to the work of their colleagues and to interpret their results in terms of the larger goals of the research program.

Integration of social scientists. The experiences of the cases show clearly that OFCOR has been successful in bringing a social science perspective into field research. There have been problems, however, in

institutionalizing a continuing role for social scientists throughout the research process. In almost all of the programs studied, social scientists were active in initiating the OFCOR effort. Nevertheless, Fig. 2 shows that, at the time of our research in 1986, social scientists constituted less than half of the field staff in all programs and less than a third in all but two. While these data challenge the belief held by some that OFCOR is primarily a social science activity, our data do show that OFCOR programs were the most common "home" for social scientists in the NARS studied.

In most of the research institutes studied, specific roles had been legitimized for social scientists—primarily for agricultural economists, but also, in a few cases, for sociologists and anthropologists. Social scientists' contributions have been concentrated at early stages of the on-farm research process—for planning OFCOR efforts, designing diagnostic surveys and analyzing results and developing field methods. Their role in performing routine economic analysis of experimental results and in monitoring of adoption has also been quite widely accepted.

In many of the cases, social scientists have also played an important role in experimenting with and developing effective and systematic methods for selecting farmers as collaborators and in developing mechanisms to encourage their direct involvement in the research process. Among the cases studied, OFCOR programs without social scientists, or with minimal social science input, tended to be the weakest with respect to actively involving farmers in the research (Biggs, in press).

Constraints in staffing partially explain the problems found in institutionalizing a continuing role for social scientists. Since social scientists have not traditionally played a major role in agricultural research institutions, foreign scientists played important roles in establishing social science disciplines in OFCOR in all but a few of the cases. It has often not been easy, however, to find nationals of equivalent status and training to replace these foreign scientists. This problem arose in all the Latin American cases in which virtually no social scientists were still involved in on-farm field research at the time of our research (about 10 years after the OFCOR efforts had been initiated). As an alternative, agronomists have been trained in basic methods of socioeconomic analysis. Effective application of these methods has been difficult to sustain, however, and the experiences of the cases indicate that this is not an effective substitute for the continued involvement of trained social scientists in the field research.

Maintaining a broader, client-oriented research agenda. It proved difficult in many of the cases to maintain an interdisciplinary perspective and broader research agenda focused on clients' needs after the first diagnostic stage was over and the enthusiasm generated by the new research activities began to wane. Stagnation set in for several reasons. It has been difficult to find funds and opportunities to bring senior scientists out from the stations to interact with researchers in the field on a regular basis (Merrill-Sands and McAllister, 1988). Social scientists, a scarce resource in most NARS, have tended to get drawn up the hierarchy into planning or other macro-level studies and are often not replace on the field staff. Training programs in OFCOR methods have often not been able to stay ahead of the turn-over of field staff, particularly in cases where the involvement of international centers has declined after a pilot phase. And, in some cases, an increasing share of the on-farm work has fallen on inexperienced junior scientists or on technicians, who do not have the status or authority to defend a broader research agenda or the validity of diverse kinds of farm-level data and information that do not conform to the conventions of agricultural research under controlled conditions.

The experiences of the cases indicate that without research managers' active management and support, there is a clear danger that the agenda of OFCOR programs can narrow from broad systems-oriented approaches to routine on-farm testing programs.

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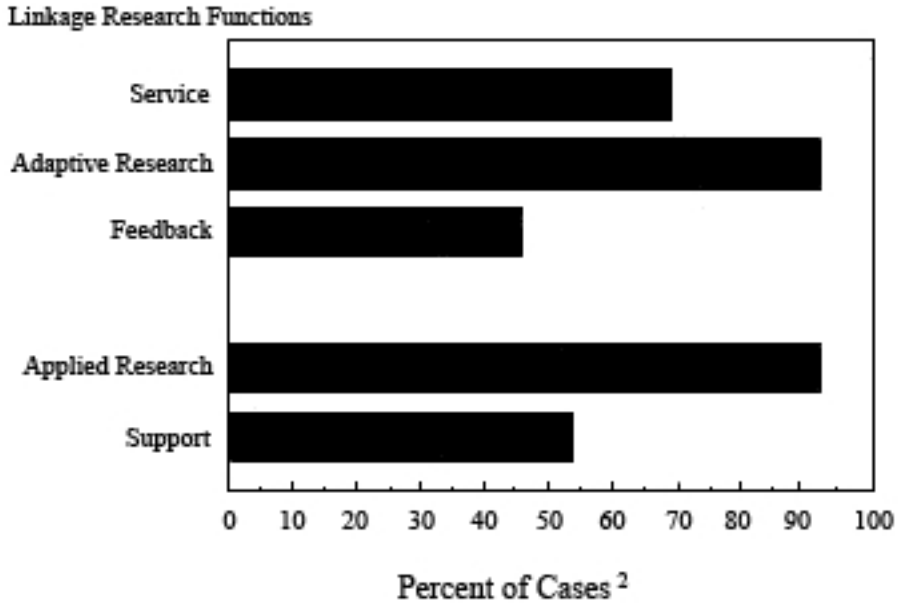
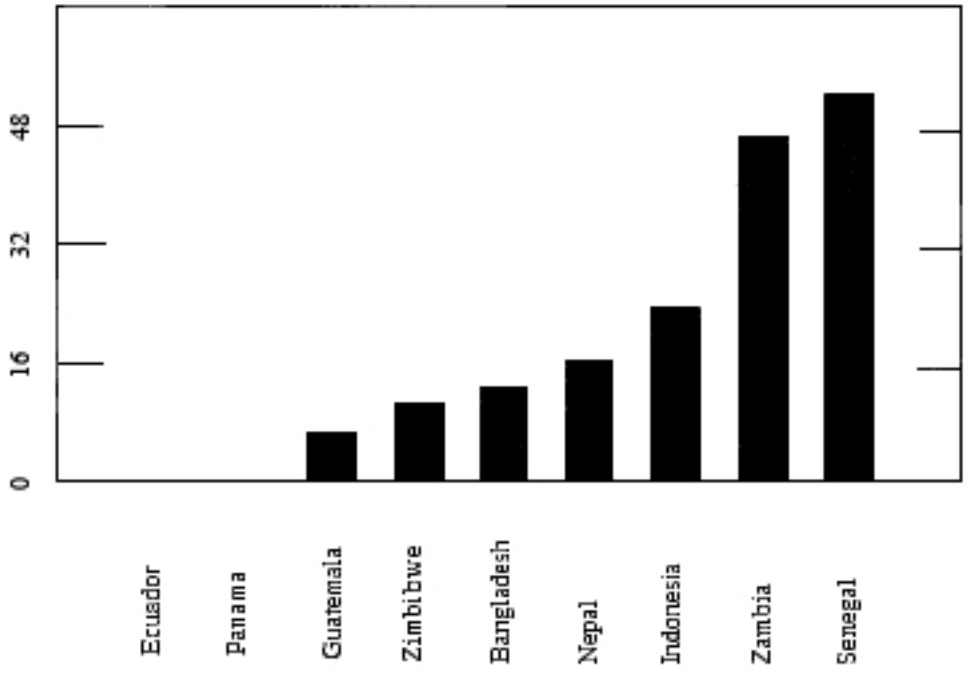
Fig. 1. Relative strength of OFCOR-OSR linkage research functions.
(Percent of cases where performance of function was moderate to strong)[1]



[1] Assessment is based on conclusions of case study reports and on systematic comparative analysis across cases.
[2] n = 13. In four of the cases-indonesia, Nepal, Senegal, Zimbabwe-different organizational arrangements for OFCOR-OSR links within the national agricultural research system were sufficiently varied to warreant separate analysis.

Fig. 2. Social scientists as percentage of all scientists on OFCOR field staff (Source: Ewell, 1988).



ANNEXES

ANNEX 1

OFCOR CASE STUDIES		
COUNTRY	INSTITUTE	SUB-CASE STUDIES
ECUADOR	Instituto Nacional de Investigaciónes Agropecuarias (INIAP)	Programa de Investigación en Producción (PIP)
GUATEMALA	Instituto de Ciencia y Technología Agrícolas (ICTA)	Prueba de Tecnología Socioeconomía
PANAMA	Instituto de Investigación Agropecuaria de Panamá (IDIAP)	Caisán Dual-Purpose Cattle Project
ZAMBIA	Ministry of Agriculture and Water Development (MAWO)	Adaptive Research Planning Team (ARPT) Central Province Eastern Province Luapula Province
ZIMBABWE	Ministry of Lands, Agriculture and Rural Resettlement (ULARR)	Farming Systems Research Unit (FSRU) Agronomy Institute (AI) Cotton Research Institute (CRI) Crop Breeding Institute (CBI) Lowveld Research Station (LRS)
SENEGAL	Institut Sènégalais de Recherches Agricoles (ISRA)	Département des Recherches sur les Systèmes de Production et le Transfert de Technologies en Milieu Rural (DRSP)
BANGLADESH	Bangladesh Agricultural Research Institute (BARI)	On-Farm Research Division (OFRD)
INDONESIA	Agency for Agricultural Research and Development (AARD)	Malang Agricultural Research Institute for Food Crops (MARIF) Central Research Institute for Animal Sciences (CRIAS) Crop-Livestock Systems Research Project (CLSR) Upland Agriculture and Conservation Project (UACP)
NEPAL	Ministry of Agriculture (MOA)	Cropping Systems Program (CSP) Farming Systems Research and Development Division (FSR&DD) Socioeconomic Research and Extension Division (SERED) Lumle Agricultural Centre (LAC) Pakhribas Agricultural Centre (PAC)

ANNEX 2

Descriptive indicators of the nine OFCOR case studies

Case Studies	National Agricultural Research System		Organization of OFCOR	Years in Operation[3]	Scale of OFCOR: (Scientist Years per Year)	
	Institutional Type	Organization of Research Program			OFCOR as % of NARS Human Resources	Size of OFCOR effort
Ecuador	Semiautonomous institute (INIAP)	Regional research stations/commodity programs	Production Research Program (PIP)[b] National program with two coordinators and 10 teams based at regional research stations	9	6	14
Guatemala	Semiautonomous institute (ICTA)	Regional research programs/commodity programs	Technology testing Department with 14 held teams in 6 regions and national socioeconomics department with limited regional representation[c]	14	34	65
Panama	Semiautonomous institute (IDIAP)	Commodity programs/ regional offices	National Of COR plan identified target regions where Of COR is implemented through special FSR projects or part time on-farm research	7	16	24
Senegal	Semi Autonomous institute (ISRA)	Multi-commodity departments/ regional stations	OFCOR located within Department of Production Systems Research and Technology Transfer (DRSP)[d], consists of 3 regional teams and a Central Systems Analysis Group	4	13	22
Zambia	Ministry (MAWD)	Commodity and factor programs	OFCOR program with national coordinator and / provincial teams at regional stations	6	20	38[h]
Zimbabwe	Ministry (MLARR)	Commodity and disciplinary based institutes and stations	OFCOR implemented by: - 8 research institutes/stations with combined on-station/on farm research programs. - Farming Systems Research Unit (FSHU) based at central station with two regional teams	6	18	26
Bangladesh[1]	BARI, semiautonomous institute of larger NARS with council	Disciplinary departments/ commodity programs	On-Farm Research Division (OFRD). with Central Management Unit at headquarters and 24 teams deployed through BARI's network of regional stations, has official mandate for on-farm research Consolidation of previous Of COR efforts	9[e]	12	104
Indonesia[2]	Ministry Dept of Research (AARD) with multiple institutes and coordinating bodies	Commodity-based regional institutes	Two principal modes of implementation: - Research institutes conduct Of COR as part of regular programs, - Of COR projects organized at AARD level with stall seconded from multiple institutes	11[f]	n/a	57[i]
Nepal[2]	I NARS: ministry II LAC and PAC[a] externally funded autonomous institutes	I Commodity programs/ disciplinary departments II LAC Multi-disciplinary research thrusts PAC Disciplinary departments	I -Farming Systems Research and Development Division (FSR ADD) with 6 FSR sites, supported by Socio- Economics Research and Extension Division (SERED), - Commodity programs with multi locational testing and outreach programs II. LAC and PAC. regional institutes with OFCOR as a generalized research strategy	14[g]	n/a	35[j]

ANNEX 3

EXAMPLE OF INDICATORS OF FUNCTIONAL PERFORMANCE

FUNCTION 6: To provide feedback to the research priority-setting, planning, and programming process so that experiment station and on-farm research are integrated into a coherent program focused on farmers' needs.

INDICATORS

FEEDBACK FROM OFCOR TO EXPERIMENT STATION RESEARCH

1. Evidence of changing priorities and/or resource allocation in OSR in response to results/findings from OFR.

   A good example comes from Ecuador where several recommendations for improved varieties of maize were cancelled for the Highlands due to the results of OFR trials with those varieties. The "improved" varieties did not perform better than local varieties under farmers' conditions. Also, an early maturing variety (I101) which had been set aside because yield performance was only moderate was eventually released in the Highlands after OFCOR demonstrated farmers' interest in an early maturing variety which would complement their local varieties.

2. Evidence that through OFCOR existing priorities for research have been or are being confirmed.

3. Evidence of OFCOR staff involvement in experiment station planning and programming of research and review of results (look for both formal and informal mechanisms).

4. Evidence of use by experiment station scientist of OFCOR written reports of results and findings (from both trials and surveys) for the justification of research programs and trials on station.

5. Evidence that senior scientists on experiment stations give credence to OFCOR as a source of information for setting research priorities.

FEEDBACK FROM EXPERIMENT STATION TO ON-FARM RESEARCH

6. Evidence that experiment station researchers participate in priority-setting, planning, and programming of OFCOR research (consider both surveys and trials).

7. Evidence that results of on-station research are used in planning and programming OFCOR trials.

8. Evidence that existing survey information (e.g. village level studies of an economics department) is used in priority-setting, planning, and programming of OFCOR.

9. Evidence that OFCOR researchers are consulting on-station scientists on a regular basis on problem identification, potential solutions, and analysis of trial results.

10. Evidence of complementarity between experiment station trials and OFCOR trials.

ANNEX 4

Disciplines Involved with OFCOR Programs

Program	Mode[1]	Disciplines Represented on OFCOR Field Teams	Social Sciences in Other Units or Departments with a Specific Mandate to Back-up the OFCOR Program
Ecuador			
PIP	A	Agronomy	Ag. Economics (to 1982)
Guatemala			
Technology Test	A	Agronomy	Social Science Dept.[2] Ag. Economics, Sociology, Anthropology.
Panama			
N. OFCOR Plan	A	Agronomy	Ag. Economics, Planning[3]
Caisan	A	Agronomy	Ag. Economics[4]
Dual-purpose L.	A	Animal Science, Agrostology.	
Senegal			
Prod. Sys. Res.	C	Agronomy, Animal Science, Ag. Economics, Sociology, Ag. Engineering.	Political Science Macro-Economics
Zambia			
ARPT	B	Agronomy, Extension, Ag. Economics.	Sociology, Nutrition[5]
Zimbabwe			
FSR Unit	C	Agronomy, Ag. Economics, Animal Science.	-
Agronomy I.	A	Agronomy.	-
Cotton R.I.	A	Agronomy, Entomology.	
Lowveld Sta.	A	Agronomy, Soil Science.	-
Crop Breed I.	A	Breeding.	-
Bangladesh			
BARI	C	Agronomy, Soil Science, Ag. Economics, Animal Science.	- -
Indonesia			
Upland Ag. & C.[6]	C	Agronomy, Animal Science, Soil Science, Ag. Economics.	-
Crop-Lvsck. S.[6]	C	Agronomy, Animal Science, Economics.	-
Maize OFR	B	Plant Breeding, Agronomy, Economics.	-
Small Rum. CRSP	C	Animal Science, Sociology, Ag. Economics.	-
Nepal			
Rice Program	A	Agronomy	-
Crop. Sys. Res.	B	Agronomy, Ag. Economics.	-
FSR & DD	C	Agronomy, Ag. Economics, Extension.	SERED[7]: Ag. Economics
LAC and PAC	C	Agronomy, Ag. Economics. Horticulture, Anthropology Agro-forestry, Animal Science, Extension.	- -

Notes on Annex 4:

1. We have divided the disciplinary composition of the teams into three modes:
   A: Generalists from broad technical disciplines, usually Agronomy (or Animal Science for livestock projects), with part-time support from specialists.
   B: The "minimal pair"; Agronomy and Agricultural Economics.
   C: Farming Systems teams which combine a broader range of natural and social science disciplines.

2. In this study, were are considering the Technology Testing and Socioeconomics departments as ICTA's OFCOR program. The former is organized regionally into field teams, the latter is a national department in support of OFCOR which has on occasion delegated scientists to work on the Technology Testing teams.

3. The central Planning and Ag. Economics departments provided back-up services to all the OFCOR projects.

4. An agricultural economist from CIMMYT worked part-time on the project.

5. These disciplines were organized into special multi-regional units within ARPT.

6. These the multi-institute OFCOR projects are advised on their programs by Technical Advisory Teams which include additional disciplines.

7. When the Cropping Systems Research Program was reorganized into the Farming Systems Research Division in 1984, the Social Scientists hived off to form SERED. Part of the mandate of this independent department is to do socioeconomic research for FSR&DD.

THE IMPORTANCE OF INVESTIGATIVE MODELS IN PROBLEM IDENTIFICATION IN FSR/E: RELEVANCE TO MALIAN SITUATION

Curtis M. Jolly, Millie A. Gadbois and Apha S. Maiga[1]

INTRODUCTION

Farming System Research and Extension (FSR/E) methodology was conceived as an innovative approach for adapting technology to the conditions of small farmers whose goals and farm management practices were ignored by traditional agricultural station research (Collinson, 1982; Hildebrand, 1986; Norman et al., 1982; and Shaner et al., 1982a). FSR/E was introduced, not to replace more traditional research methods, but to incorporate farmer participation, thus improving the efficiency of such research (Rohrbach, 1980). After a decade of research, donor agencies and local governments have begun to doubt the ability of FSR/E to produce timely and meaningful results in a cost-effective manner.

The major reasons for the failure of FSR/E to produce results have been summarized by Maxwell (1984), Chambers (1983), Davidson (1987) and Jolly (1988). The reasons given are the failure of FSR/E researchers to find a common methodology and the lengthy methodological approach in which researchers consume much time debating proper research procedures, establishing criteria for representative farmers and defining such concepts as the farming system, recommendation domains, research zones and diffusion domains. The concentration of researchers' efforts in defining farmers' problems through meticulous and thorough surveys that take an excessive amount of research time has also retarded progress. While data have been collected for the design of farm prototypes, projects have usually ended before these prototypes were developed. Although some researchers think that models are complicated and not needed in FSR/E, a few have recognized their importance at the initial stage of FSR/E. In this paper the importance of investigative models at the diagnostic phase of FSR/E is evaluated to determine their effects as tools in problem identification.

MODEL DEFINITION

A model, as stated by Lange (1947), is a deductive set of theorems to be subjected to empirical tests. James (1988) described a model as an "abstract" representation of an actual situation in the sense that it portrays reality with only that information thought to be essential to understanding how that system works. He further stated that abstraction is not a process of excluding all reality, but one of isolating those aspects of reality necessary to grasp the workings of a system and eliminating the remainder.

Baker (1974) classified models as investigative or decision models. Investigative models are used to test and explain phenomena novel to researchers, while decision models are limited to the specification of elements relevant to specific classes of decision makers and decision problems. Investigative models are used empirically to test a proposed product whose accuracy in terms of features is of critical significance. While Baker (1974) stressed the importance of empirical accuracy for models used for investigative purposes, Lange (1947) indicated that the models must only have elements of the real world. James (1988) stated that whether the models are physical or theoretical, the essential point is that the result of abstraction still portrays reality and that the models' properties be directly and strictly comparable to the real world.

Cohen and Nagel (1934) have stated that we cannot take a single step forward in any inquiry unless we begin with a suggested explanation of the original problem. Such tentative explanations are suggested to us in the subject matter, data presented and/or previous knowledge. Therefore, models designed to clarify the subject matter of research may be developed at any stage of inquiry.

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USE OF MODELS IN FSR/E

The first task faced by the FSR/E researcher is to bring order out of the mass of data with the hope that either a problem can be identified, or that some known problem can be solved with evidence yielded by data. FSR/E methodology emphasizes the use of secondary data and the collection of additional primary data at the beginning of inquiry. Many researchers have alluded to the lack of a common methodology for FSR/E, and a variety of approaches have been identified. Collinson (1982) has outlined a methodology for conducting FSR/E research in which time requirements for the literature review, exploratory survey and testing of technology were specified. Other methodologies have been proposed by Shaner et al. (1982a), Simmonds (1985) and Maxwell (1984). These methodologies have concentrated on various stages of FSR/E, from problem identification to on-farm research. A general outline of the steps in the FSR/E process as presented by Shaner, et al. (1982b) is found in Figure 1. This schema does not connote the explicit use of models. In fact, though all FSR/E methods seem to have similar elements and some have recommended the use of prototype farms at the on-farm trial or technology-testing stage, none have included the explicit use of models at the problem-identification stage.

Rohrbach (1980) has stressed that there is great difference in farm management research, which frequently makes explicit use of models, and that of FSR/E. The difference was that FSR/E stressed a holistic approach in farm analyses, while farm management research stressed farm reorganization. Whatever the difference, there is a close relationship between both types of research.

The key question is whether investigative farm models can be useful in problem identification and provide a guide to inquiry. As Cohen and Nagel (1934) have stated, hypotheses should be developed at every stage of the inquiry. Since a model is nothing more than a structured set of hypotheses, it should also be embedded in the research methodology. Model building at different stages of FSR/E should bring order to the mass of existing data and accelerate the research process.

The integrated FSR/E approach seeks to simulate the breadth of activities and considerations that farmers do intuitively. Shaner et al. (1982a) stated that the more researchers are able to assimilate farmers' decision-making processes, the more accurately they will be able to anticipate farmers' decisions. It is, however, difficult to simulate farmers' actions and to determine whether a new technology produces more from a given set of resources or helps stabilize inputs and outputs without proper micro and macro analyses.

The micro analysis evaluates the efficiency of the given technology, the allocation of on-farm resources and whether the technology meets farmers' requirements and objectives within the given social environment. In the FSR/E process, technology evaluations are usually conducted immediately after the diagnostic research phase. At the design phase of the improved system (Fig. 1), investigative models can be useful in determining which technology would have the largest impact on farmers goals and which would be most appropriate for the farmers' situations. Both secondary data and diagnostic survey data could be used for the development of these models. The investigative models will also indicate the validity of the data source and identify data needs. Hypotheses constructed in model form should be tested at this stage in order to determine its potential effects upon the farming system and the national strategy and goal.

Macro-analysis situates the farm unit within the farming system and the national macro-model. The research to be carried out must show how the farm goals are interwoven within the fabric of the national goals. Policy makers want to know how the on-farm research will help the individual and country attain their common goals. To do this, representative models of the farming system must be simulated. The relationship between the individual farm model and the macro-model is demonstrated in Fig. 2. The attainment of the national goal is dependent on the individual farm units attaining their full potential. Technologies that will not enhance the attainment of farmers' and national goals will be eliminated at the early stages of research.

The use of investigative models will keep research and development from becoming diffused or diluted by concerns that do not relate to farmers' needs and national goals. Shaner et al. (1982a) mentioned that the use of models can be important in searching for feasible farm solutions. Other researchers used linear programming as part of the research process. None of these researchers stated whether these models were decision models or investigative models or at what stage of the research process they should be used.

In this paper investigative models are developed for three structural recommendation domains for a farming system in the southern research zone of the Operation Haute Valle (OHV) in Mali to demonstrate how these models can be used at the diagnostic phase to guide inquiry and efficient data collection.

METHODOLOGY

The OHV zone encompasses an area of 31,530 km^2 that represents 2.5% of the Malian territory and 11% of the cultivated rainfed area. The climate varies from Sahelian (600 mm rainfall) in the northern sectors of Banamba and North Koulikoro to Sudano-Sahelian (12,000 mm rainfall) in the south in Ouelessebougou, Bancoumana and Kangaba. The soils are composed of silty clay and gravelly loams covering a layer of lateritic hard pans. The primary ethnic groups are Bambara, Sarakole and Peuhl, and there are several other smaller groups as well.

Information about the farming systems of the region were obtained from a literature review that included reports on production, distribution of crops and agricultural statistical reports of Mali. Other materials on cropping systems, labor use and equipment requirements for the production of crops in other zones and other West African Countries were also included. Information was also collected from a rapid reconnaissance survey, a typology report and two other reports prepared by the FSR/E team of the OHV zone.

These data were used to develop three models of representative farms of the southern farming system zone. Each of these farms represented one structural recommendation domain. The three recommendation domains were based on levels of mechanization of the farm family units. The three domains were well-equipped units with at least two complete draft animal teams at their disposal; moderately equipped units with at least one complete draft team; and traditional units, in which cultural practices were all performed manually.

A matrix of activities and resource constraints was prepared. This matrix appears in Tables 1 and 2 and contained 15 activities, 23 resource constraints on the right hand side (RHS) and an objective function. Activities were divided into two groups, those based on recommended practices by the OHV extension agents and those based on farmers practices. All the constraint coefficients were similar for all three farm types, but the resource constraints varied according to farm type.

Certain assumptions were made about the farm family decision-making process. It was assumed that all farm families were engaged in farming to maximize net revenues. This is not absolutely true since many reports showed that farmers consider multiple goals in making farm-level decisions, and lexicographic ordering of goals was evident (Barnett et al., 1983). It is also true that consumption production linkages affect production decisions separately from consumption decisions. Models that consider production decisions separately from consumption decisions result in failure to structure the peasant farm in its dual role of production enterprise as well as consumption unit (CRED, 1982). Other sociological factors on family structure could also be simulated. However, the investigative model needs to be kept simple enough for the investigators to study a few problems confronting farmers and, therefore, to be better able to ask relevant questions about the more complicated issues of family organization. Thus, it was necessary to limit number of activities to the most important ones. The choices of activities were based upon data collected from farm surveys and the researchers' judgment.

Ellis (1988) stated that each theory of peasant farm organization assumes that the peasant household maximizes one or more household objectives. Assuming that farmers are out to maximize net revenues from their farming activities, linear programming models were developed for each of the three farm types. Linear programming is a mathematical technique that can be used to maximize a linear objective function subject to constraints. The model can be represented as follows:

(1) Maximize $Z=CX$
(2) Subject to $AX = < B$
(3) and $X = > 0$

where: Z is the objective function to be maximized; C is the vector of costs and returns; X represents activities; A is the matrix of technical coefficients; and B is the vector of constraint coefficients. The values for costs and returns were obtained from enterprise budgets developed by the FSR/E teams in the OHV zone. The coefficient constraints were obtained from past FSR/E reports and other documents. Sensitivity analyses were conducted to determine whether farmers' decisions would change under risk conditions.

A chance constraint programming model by Belleza and Gillespie (1986) was used to determine optimal solutions subject to a probability of the farmer falling below a desired goal. The goal was a given income level that would provide the farm with at least 200 kg of rice per capita per annum, plus a sum to pay for other basic ingredients. The 200 kg of rice was considered a basic level of food self-sufficiency as determined by FAO.

In the chance constraint model, the objective function was to maximize net returns subject to discrete and stochastic constraints. The model contained the same number of activities and rows as the first models, but labor-hiring activities were allowed to supplement July and December labor. The stochastic constraints included six different states of nature (Y_1, Y_2 .....Y_6). This represented the chance constraints portion that indicated returns due to yield outcome. The outcomes were calculated from the yield levels obtained under different climatic conditions. The expected net returns per crop due to yield variability are seen in Table 3. By incorporating chance constraints in the model, the maximum and minimum expected incomes were calculated.

The states of nature had uneven probabilities. The sum of the probabilities adds up to 1. This is seen in Table 3. Deviations are computed for each possible state of nature by subtracting the calculated net returns for each state of nature form the T-level value. The model is primarily concerned with negative deviations below the reference level. These negative deviations are then multiplied by the probability of their occurrence given in the Theta row. The T-theta column sums up the Theta row and multiplies the result by -q* in the SUFCON row.

The value for q* is obtained by the formula 1/p where the p value represents the probability of falling below the desired goal. The whole process of calculation allows the goal of meeting the minimum food requirement to be satisfied. The SUFCON row guarantees the constraint risk/income reference point (T-level) that satisfies the equation:

$$IT-q^* (O (T)) = >g.$$

This equation simply suggests that the T-value minus the negative deviation times its probability of occurrence is greater than or equal to the target goal. Results would show that the higher the level of probability, the greater the risk and the higher the expected income.

RESULTS AND DISCUSSION

Farm Plans Under Risk-Free Conditions

First we discuss the results of the risk-free farm plans. These are presented in Table 4. An examination of the activities included in the farm plan for the traditional farmers indicate that this group, given the resource constraints, would produce 0.2 ha of tobacco, 0.7 ha of sorghum, 1.45 ha of rice and 0.5 ha of peanuts. The sorghum, rice and peanuts were all produced using farmers' practices. The maximum net income from the production of the combination of crops was 212,659 FCFA (US$708.86, 300 FCFA = $1.00). July and December labor limited the amount of acreage planted. The level of investment limited the production of cash crops.

The farm plan for moderately equipped farmers produced 1.1 ha of cotton, 1.0 ha of tobacco, 0.02 ha of sorghum, 2.0 ha of rice and 1.0 ha of peanuts. The sorghum, rice and peanuts were all produced using farmers' practices. The maximum net revenue for the farm plan was 547,089 FCFA (US$823.63). The farmers were also constrained by July and December labor and the level of investment.

The farm plan for the well equipped farmers contained 2.6 ha of cotton, 1.0 ha of tobacco, 1.0 ha of sorghum, 2.0 ha of rice and 2.0 ha of peanut. The rice, peanuts and sorghum were produced using farmers' practices. The net income from farming was 880,000 FCFA (US$2,933). Farmers in this category were constrained by July and December labor, investment capital, tobacco land and peanut land.

It must be noted that had farmers not been constrained by the level of investment, all lands suited for tobacco production would have been planted. Tobacco production was also limited by December labor requirements. The quantity of peanuts produced was constrained by the market for peanuts at the local level.

A comparison of the risk-free farm model results in Table 4 with the farm organization observed during the rapid reconnaissance survey (Table 5) shows that the farm models and the existing farm organizations were not very different. Farmers tended to diversify by planting a number of cereal crops with at least one cash crop. The models showed that slight reorganization could lead to increased income. Given resource constraints, the traditional farmers' income was 94% of the income of the modeled farms, the moderately equipped farmers' income was 83%, and the well-equipped farmers' income was 86%. This indicates that not very much improvement can be obtained in farmers' income unless resource constraints are removed. The comparison shows that the greatest improvement in farm income could be obtained by a reorganization of the moderately equipped farmers.

What do these investigative models tell the researcher that he would not have observed through simple observation? It was noticed that the recommend practices advocated by the extension agents for cereals will

not be adopted by any of the three groups of farmers. Jolly et al. (1987b) observed that farmers do not follow the recommended practices for cereals and peanuts extended by the OHV extension agents. Farmers do, however, follow the recommended practices for the cash crops. This means that unless changes can be made in yields, cost of inputs or prices of products, farmers will continue using their own practices.

All farmers used animal traction services, but animal production did not enter into the solution. The rapid reconnaissance team observed that farmers were willing to pay for animal traction services, but farmers claimed that there were difficulties in keeping large animals on their farms. Most farmers in the area placed their large animals in the care of the Peuhl herdsmen. Animal traction services constrained farm development only for the traditional farmers, but moderately and well equipped farmers were unconstrained by animal traction services. It has been observed by researchers that animal traction was inefficiently used by Sahelian farms. The farm plan indicated that July and December labor were the most limiting factors. These apparent labor constraints bear further investigation. From observation it would appear that plowing and sowing activities for most of the cereal and peanut crops took place in July, and harvest was in December.

The models did not include millet, corn and mixed cropping of peanuts, sorghum, millet/cowpeas or any of the other combinations. This observation should raise the curiosity of researchers. Why do farmers practice mixed cropping when mono-cropping would result in greater returns to their limiting resources? Some researchers have mentioned that farmers use this as an insurance factor. Harwood (1979) stated that there is evidence that when one of the crops in a combination is damaged early in the growing season by adverse agro-climatic conditions, pests or diseases, the other may compensate for the loss by doing better. He warned that there was little available data to indicate how general or important this phenomenon is in actual practice. Corn produced using recommended practices was not competitive with the other crops produced using farmers' practices. It was observed during the survey that farmers did plant corn using recommended practices. When inquires were made, the farmers stated that they planted less of their land in cotton and more in corn because a fall in the price of cotton was anticipated. This is a subject for further investigation when more accurate data become available.

Millet was never included in the farm plan, yet in this region millet is one of the basic crops. It is also true that millet is one of the principal staples and is consumed at festive occasions. Rice, using farmers' practices, was included on all farms. This is interesting since rice was considered a low-priority crop in the project proposal. The donor agency was not supportive of rice projects or rice research. Since farmers were interested in traditional rice production, the importance given to rice research in the research project should be reconsidered.

Since all farm types experienced labor shortages in July and December, the level of resource endowment did not affect labor scarcity. The shortage was a problem of cultural practices or labor organization rather than of the level of mechanization. The use of animal traction did not remove or reduce labor bottlenecks. As Delgado and Mclntyre (1982) stated, farming systems research aimed at extending oxen-drawn technology must analyze companion innovations that reduce the time required for weeding and harvesting. They further stated that using hired labor alone to cope with labor bottlenecks from increased acreage is not likely to be profitable in the sahel unless technological change boosts crop yields above traditional levels.

Farm Plans Under Risky Conditions

Results of the farm plans under risky conditions are seen in Table 6. The farm plan for the traditional farmer did not change under the constraints of the six states of nature. The production levels remained the same. It was expected that under risky conditions farmers would alter cropping systems to include mixed cropping. It is generally theorized that mixed cropping is practiced by small farmers as an insurance against crop failure. Farmers do practice mixed cropping for one reason or the other. In this case, additional data to determine why farmers practice mixed cropping should be collected or the validity of the coefficients used in the model should be questioned.

The farm plan for the moderately equipped farmers did not deviate a great extent from that of the risk-free models. Cotton was removed from the model and cattle included. A high degree of risk is associated with cotton production, considering the level of investment and yield variability. The returns above variable costs for the farm were only slightly lower than that of the risk-free models.

A few changes in the farm plan of the well-equipped farmers were noticed. Cotton production was excluded while traditional rice production was featured prominently. Cattle were also brought into the model. The returns above variable costs were only slightly lower than that of the risk-free model. The returns per labor unit and capital were much lower.

The activities included in all three farm plans had positive net returns for all states of nature. The only cash crop that was included in the farm plan was tobacco. In spite of the high level of investment required, the returns above variable costs are very high for tobacco. It is surprising that cotton never came into the farm plan. The farm plan indicated that farmers in all three categories would produce only cereal using traditional practices whether the situation was risky or risk-free. This should send a signal to researchers and extension agents. Kagbo (1986) found that only 17% of farmers in the southern section of the research zone applied fertilizer to their sorghum. Jolly et al. (1987a), using partial budget analysis, showed that even with cereal yields from experimental data, it was not profitable for farmers to produce cereals using recommended practices. Yet the extension agents were encouraging farmers to use recommended practices, including fertilizer applications, in the production of cereals.

Applied research teams have been busy conducting trials on cereals based on the recommended package extended by the extension agents. The use of simple models such as those used here, using experiment station and secondary data, could have been applied to determine as soon as possible which technologies were actually likely to be beneficial to farmers. If researchers had been made aware earlier that yields produced by cereal crops under experimental conditions could not justify fertilizer use, they could have channeled their efforts towards the development of technology based upon traditional practices. In that way much time and money might have been saved.

SUMMARY AND CONCLUSION

The investigative models used in the research process were rudimentary but provided some insights into research problem solving. The coefficients used were rough estimates taken from past research and the diagnostic survey, but the results derived from their use have helped confirm observations made at the diagnostic phases of the FSR/E. The models have made use of primary and secondary data sources and have pointed out the lacuna in the current data base.

Some results deviated from normal expectations. Millet was not included in the farm plans, but almost all farmers in the southern zone did, in fact, produce millet; as such, this is a subject that merits further investigation.

The models showed that only minor changes were required to increase farm income to its full potential. Farmers in the traditional category were operating at almost full capacity. The worst cases were farmers in the moderately equipped category who were 17% away from achieving an income level equivalent to that of the model farm. Farmers were engaged in many non- and para-agricultural activities. Farmers also produced a number of minor crops that are sold to increase income, and these were not included in determining the farmers' income before modeling. Therefore, it can safely be said that all farmers are operating efficiently given their constraints.

Policy goals based on current farm production levels that require only minimum increase in yields would be achieved. The results here indicated that national goals set on existing production levels could be attained, but higher goals would require elimination of production constraints. The results also showed that higher production levels might be obtained by fine tuning the farm organization of the moderately equipped farms.

The models raise some fundamental questions for policy makers, extension agents and researchers. These include questions about the importance of animal traction in attaining national goals, questions about which endogenous and exogenous variables should be manipulated to attain farm and national goals and questions about the existing packages of recommended practices.

Thus, although their use certainly should not exclude other methods of problem identification, this exercise has demonstrated that investigative models based upon secondary and preliminary diagnostic data can facilitate problem identification. In the future there should be further examination of the time consumed and the cost-effectiveness of investigative models. Microcomputers form part of the equipment package of all FSR/E projects, so the cost associated with the use of the microcomputer is minimal. The time required to build a simple model is only a few hours. The benefits and costs derived from the use of investigative models have not been measured, but from a cursory glance it would seem that the benefits far outweigh the costs.

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Table 1: Activities, resource constraints for Model Farms, for Recommended Domains in the OHV Zone, Mali, 1988

Row	Corn	Millet	Sorghum	Peanuts	Cotton	Rice	Tobacco	Cattle	Corn/M	Mill/M	Ara/Sorq	Mill.T	Sor.T	Rice.T	Peanut.T
Obj Fen	38174	18701	35201	80000	91695	42000	200000	30000	42000	25000	43000	22000	35000	60000	120000
Upland	1	1	1	1	1	1	1		1	1	1	1	1	1	1
Swampland															
Pastureland								1						1	
Total Land	1	1	1	I	1	1	I	1	1	1	1	1	1	1	1
January labor		10	10		25	20	10	3	10	10	10	8	8	8	
February labor		4	4		15	3	21	3	4	4	4	3	3	2	
March labor		2	2				15	4	2	2	2	1	1		
April labor	10						30	6	10						
May labor	20	10	10	4	20	10	25	6	15	10	14	10	10	10	
June labor	15	15	15	24	21	20	10	3	16	18	20	18	18	23	4
July labor	13	13	15	20	20	25		2	15	19	22	18	18	26	28
August labor	3	11	11	14	15	22		2	12	20	14	12	12	26	22
September labor	10	3	3	3	10	14		2	14	10	3	3	3	18	16
October labor	6	14	14	16	5	8	3	2	15	12	16	10	10	10	3
November labor	6	2	2	2	4	16	10	2	6	2	2	2	2	4	2
December labor		10	10	5	20	35	5	2	10	10	15	10	10	30	5
April-May AT Labor	5	5	5	5	5	5	10		5	5	5				
June-July AT Labor	15	15	15	15	15	18			15	15	15				
August-September AT Labor	15	15	15	10	10	5			15	15	12				
October-November AT Labor	2	2	2	2	2		20		2	2	2				
Investment	44326	32601	32601	26000	70305	72650	120000	50000	40000	40000	28000				
Tobacco land							1								
Peanut land				1											

Table *2.* Resource constraints and RHS for model farms, 1988.

Resource Constraints	RHS for Farmers		
	Traditional	Moderately equipped	Well equipped
Upland[1]	6	8	10
Swampland[1]	2	4	2
Pastureland[1]	4	6	6
Total Land[1]	14	20	22
January labor[2]	64	104	184
February labor	54	94	184
March labor	64	104	184
April labor	64	104	184
May labor	58	98	178
June labor	54	94	174
July labor	64	104	204
August labor	64	104	184
September labor	66	106	186
October labor	54	94	174
November labor	54	94	174
December labor	54	94	194
April-May AT Services	40	80	160
June-July AT Services	42	82	162
August-September AT Services	42	82	162
October-November AT Services	42	82	162
Investment[3]	25,000	200,000	300,000
Tobacco land	0.5	1.0	1
Peanut land	0.5	1.0	2

[1] The land available to each farm type was based on results of the rapid reconnaissance survey.
[2] This was all based on the active labor available to each farm type according to the rapid reconnaissance survey. The traditional farm size had three active labor man equivalents, the moderately active lands five active labor man equivalents, and the well-equipped had eight active labor man equivalents.
[3] The level of investment was based on respondents answers given during survey, 1986-1987.

Table 3: Activities, resource constraints for model farm, under risk, for a recommendation domain in the OHV Zone, Mali, 1988.

Row	Corn	Millet	Sorghum	Peanuts	Cotton	Rice	Tobacco	Cattle	Corn/M	Mill/N	Ara/Sorg	Mill.I	Sor.I	Rice.I	Peanut.I	I'Level	Y1	Y2	Y3	Y4	Y5	Y6	THETA	RHS
Obj Fcn	38174	18701	35201	80000	91695	62330	200000	30000	42000	25000	43000	22000	35000	60000	120000									6
Upland	1	1	1	1	1		1		1	1	1	1	1		1									2
Swampland						1								1										4
Pastureland								1																14
Total Land	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1									64
January Labor		10	10		25	20	10	3	10	10	10	8	8	8										54
February Labor		4	4		15	3	21	3	4	4	4	3	3	2										64
March Labor		2	2				15	4	2	2	2	1	1											64
April Labor	10						30	6	10															58
May Labor	20	10	10	4	20	10	25	6	15	10	14	10	10	10										54
June Labor	15	15	15	24	21	20	10	3	16	18	20	18	18	23	4									64
July Labor	13	13	15	20	20	25		2	15	19	22	18	18	26	28									64
August Labor	3	11	11	14	15	22		2	12	20	14	12	12	26	22									66
September Labor	10	3	3	3	10	14		2	14	10	3	3	3	18	16									54
October Labor	6	14	14	16	5	8	3	2	15	12	16	10	10	10	3									54
November Labor	6	2	2	2	4	16	10	2	6	2	2	2	2	4	2									54
December Labor		10	10	5	20	35	5	2	10	10	15	10	10	30	5									40
April-May AT Labor	5	4	5	5	5	5	10		5	5	5													42
June-July AT Labor	15	15	15	15	15	10			15	15	15													42
August-September AT Labor	15	15	15	10	10	5			15	15	12													42
October-November AT Labor	2	2	2	2	2		20		2	2	2													25000
Investment	44326	32601	32601	26000	70305	72650	120000	50000	40000	40000	28000													0.5
Tobacco land							1																	0.5
Peanut land				1											1									
Y1	120694	55000	96799	240000	253695	197350	400000	60000	84000	50000	86000	55000	71500	144000	240000	-1	1							
Y2	79424	41250	63799	160000	222695	129850	300000	45000	63000	37500	64500	41250	53625	108000	180000	-1		1						
Y3	58799	34375	47299	120000	132195	88080	250000	37500	52500	31250	53750	34375	44688	90000	150000	-1			1					
Y4	38174	27500	30799	80000	91695	72650	200000	30000	42000	25000	43000	27500	35750	72000	120000	-1				1				
Y5	17549	-20625	14299	40000	51195	28580	150000	22500	31500	18750	32250	20625	26012	54000	90000	-1					1			
Y6	-3076	-13750	14299		10695	-5150	100000	15000	15000	12500	21500	13750	17875	36000	60000	-1								
THETA																	0.12	0.12	0.2	0.24	0.16	0.16	-1	
SUFCON																1							-5	135000

Table 4: Model farm plans, under risk-free situation, 1988.

Activities	Unit	Area planted (ha)		
		Traditional	Moderately	Well-equipped
Cotton	ha		1.1	2.6
Tobacco	ha	0.2	1.0	1.0
Sorghum-Traditional	ha	0.7	0.2	2.5
Rice-Traditional	ha	1.45	2.0	2.0
Peanut-Traditional	ha	0.5	1.0	2.0
Income (FCFA)		212659	547089	881864
Number of Active labor units		3	5	8
Returns to labor		70886	109417	110233
Level of Investment		25000	200000	300000
Returns to Investment		8.5	2.7	2.9

Table 5: Farm organization and type of enterprise for farms in the southern zone of the research area of the OHV farming systems team, 1982.

Activities	Unit	Traditional	Moderately Equipped	Well-Equipped
Rice Traditional	ha		0.5	2.0
Sorghum Traditional	ha	3.0	2.0	1.1
Peanuts Traditional	ha	0.5	1.0	2.0
Maize Traditional	ha	0.5	0.4	0.5
Millet Traditional	ha		1.2	2.0
Tobacco	ha			0.5
Cotton	ha		1.5	2.0
Cattle	ha			
Active Labor Units		3.0	5.0	8.0
Income	FCFA	199700	456680	761890
Returns to Labor	FCFA	66567	91360	95236
Income/Income of Farm Model	%	94	83	86

Table 6: Model farm plan under risky conditions.

Activities	Area planted (ha) and returns		
	Traditional	Moderately	Well-equipped
Tobacco	0.2	1.0	1.0
Sorghum Traditional	0.7	0.3	4.8
Rice Traditional	1.4	3.0	2.0
Cattle	0.0	3.0	5.0
Peanut Traditional	0.5	1.0	2.0
Income (FCFA)	212659	496500	878000
Number of active labor units	3	5	8
Returns to labor	70886	99300	109750
Level of Investment	25000	250000	350000
Returns to Investment	8.5	1.9	2.5

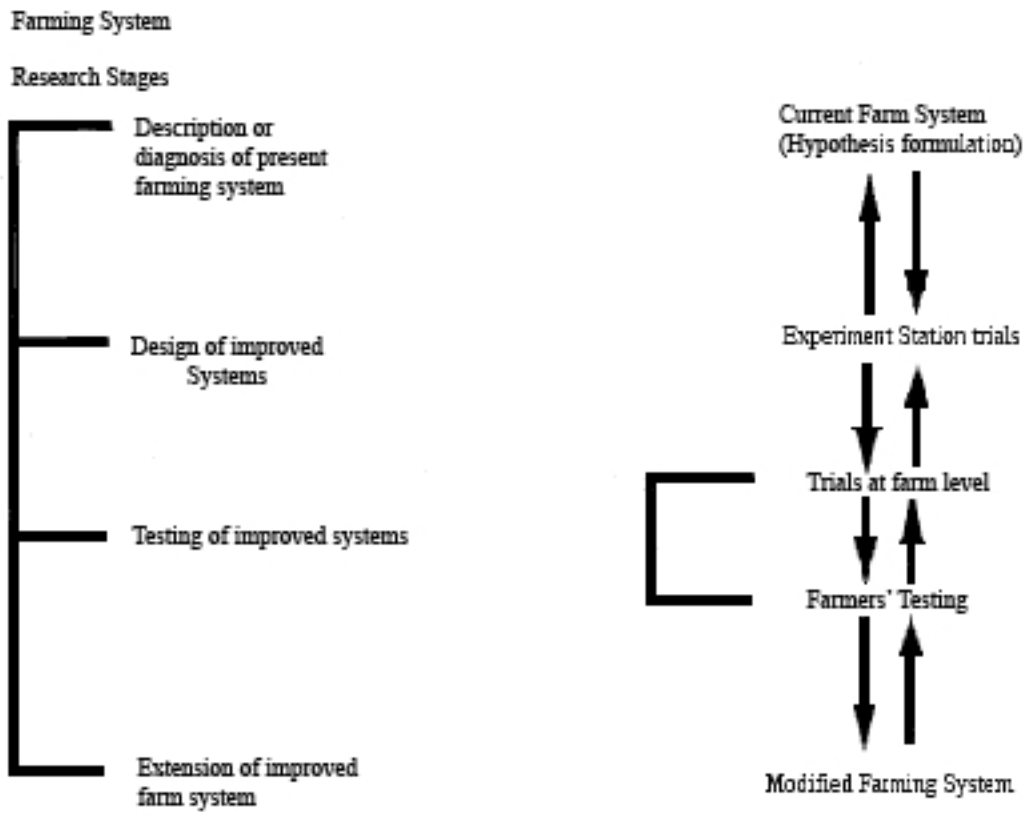

Fig. 1. Schematic framedwork for farming systems research at the farm level.
Source: Shaner et al., 1982b.

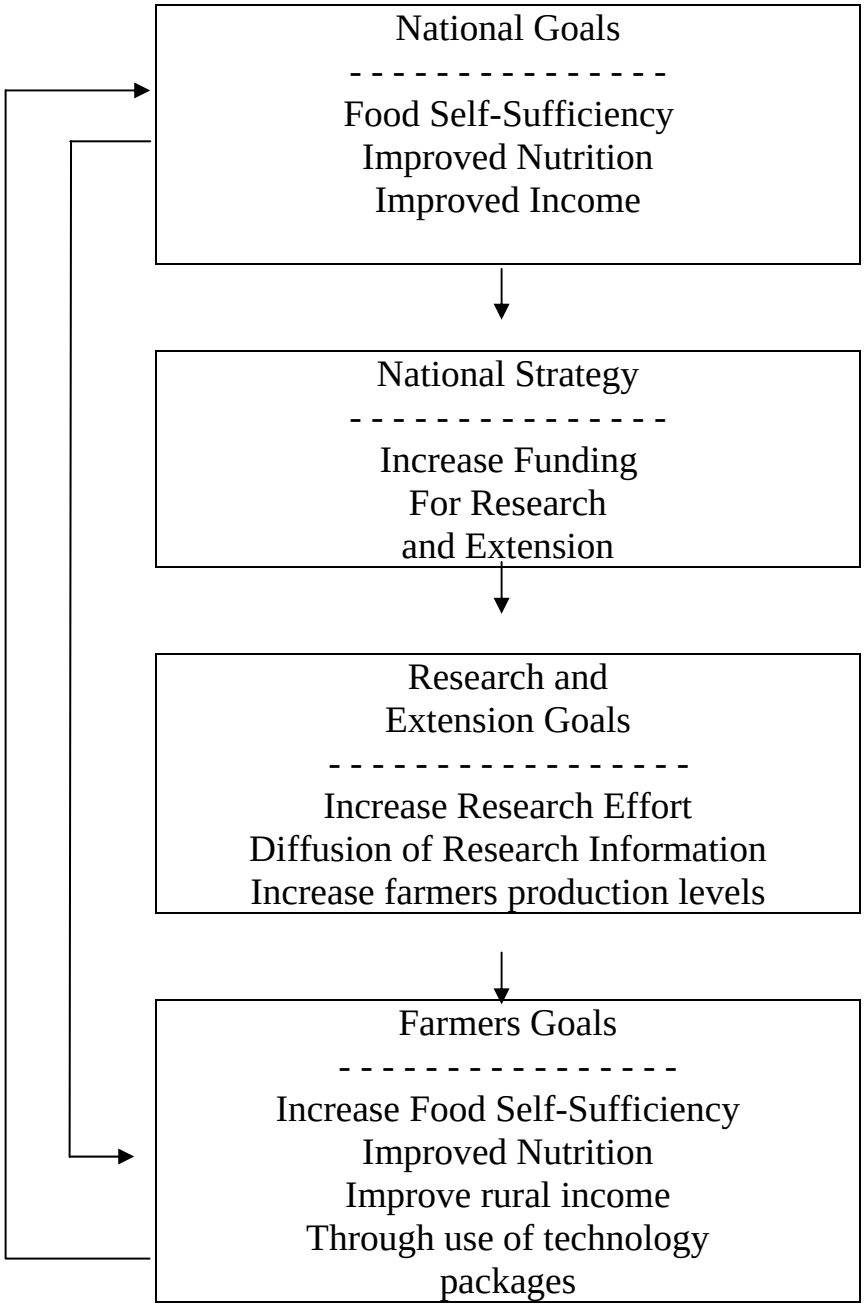

Fig. 2. Macro-economic model showing the relationships between national goals and strategy and farmers' goals and strategy.

A FARM TYPOLOGY: A PRODUCT AND A TOOL FOR A DEVELOPMENT PROGRAM

Catherine Laurent[1]

INTRODUCTION

A typology of the farm enterprises of a region allows one to characterize the diversity of production systems and to understand the relationships between farms and their socio-economic environment, including development efforts. In this respect, it provides an important tool for development agents.

A typology may proceed from a specific research process conducted a priori in a given area. It may also result from an empirical approach. This latter approach was adopted in a development project for small dairy producers of the Kilimanjaro area in Tanzania.

The detection and characterization of farm enterprise diversity resulted from joint reflection that was carried out in parallel with the implementation of the first phase of the project. This enabled us to question the small dairy producer model considered to be representative at the beginning of the program and to construct a typology of production systems for the 80,000 farms of the Kilimanjaro area.

This typology was not conceived as a tool for individual advice or diagnosis, but as a decision making aid in the management of a development program involving several tens of thousands of farms.

The objective of this paper is therefore not to give a detailed account of the results of the development program but to highlight some of its methodological points that resulted in establishment of a typology of production systems. This typology is itself used as a development tool in the second phase of the project.

PRESENTATION OF THE KILIMANJARO AREA AND OF THE DAIRY DEVELOPMENT PROGRAM

The Area

The Kilimanjaro-Arumeru area is located on the Kenyan border in the north of Tanzania (Fig. 1). It is widely open to outside influences. The region is an important commercial center (national coffee board in Moshi) as well as a major tourist area (national and game parks) with areas that are favored from an agroclimatic point of view, where there is an intensive agriculture. It is therefore considered one of the richest areas in Tanzania.

The area is marked by great variability and contrast in its physical environment. On the one hand there is the Masai plain that lies at an average altitude of 700 m; its cultivation is made difficult by soil salinity. It is mainly used by nomadic or settled herdsmen as rangeland for their herds of cattle (Tanzanian Shorthhorn Zebu) and small ruminants. On the other hand there are the mountain massifs, and particularly Kilimanjaro massif, on which crops extend from the plain up to the forest at an altitude of 2200 m.

It is there, in the highlands between 850 and 2200 m, that the great majority of small farms are found. On small-sized plots (less than 1 ha) are intercropped coffee, one of the country's main sources of foreign currency, and plantain bananas, which is the basic food for the families. This area, "the coffee/banana belt" benefits from a bimodal rainfall regime. Total rainfall increases with altitude, and its distribution over the year varies according to slope exposure (Fig. 2). Although there is enough rainfall above 850 m to grow perennial crops, below this altitude crops can be grown only during the rainy season.

In the coffee/banana belt, the farms cover the entire east, south and southwest slopes of the massif, and population density is particularly high: an average of 650 inhabitants/km^2. Housing is dense but not grouped, and in contrast to other regions of Africa, in the Chaga society, the ethnic group which lives on Kilimanjaro, the nuclear family prevails. The notion of a village does not mean an agglomeration of houses but rather an administrative unit delimiting a group of houses, which are uniformly scattered throughout the area.

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In addition to the house-plot itself, some families own land in the lowlands where they grow beans and maize during the rainy season. These fields are located on volcanic soils in the foothills of the massif on the border of the Masai rangelands. The Masai rangelands are protected by regulations prohibiting cultivation. However, in some areas, these regulations have not been enforced in recent years.

The Place of Livestock Husbandry

Most of the cattle in both regions belong to the livestock owners living on the plains. However, more than 120,000 cattle belong to smallholders in the coffee/banana belt.

These smallholders keep their Tanzania Shorthorn Zebu or improved dairy cows such as Holstein, Jersey or pure bred or crossed Ayrshire in the highlands. The cattle are kept entirely in windowless tie-in stalls and are fed mainly with crop by-products such as banana leaves and stems, maize stalks and leaves, bean straw, weeds or grass cut from the roadsides. Improved grass crops *(Tripsacum laxum, Pennisetum purpureum, Setaria sphacelata)* grown around the farms or on tiny plots sometimes supplement this basic diet. Refused feed serves as animal litter, which is then used as fertilizer for the coffee/banana plots. Thus livestock is a key element for fertilization of highland plots.

Livestock also plays an essential role in the human diet. In this area of quick population growth (3%/year), milk is a traditional food, especially for children. The current milk production in the region from both smallholders and a few large-scale state farms is not enough to meet the needs of the population. The large towns in the area such as Moshi, with about 100,000 inhabitants, and Arusha, with about 150,000 inhabitants, obtain most of their milk from milk powder provided by international aid from the EEC, or the USAID/World Food Program.

The Dairy Development Program

The small dairy producers' development program of the Arusha and Kilimanjaro regions was initiated in 1983 by the Tanzanian Ministry for Agriculture and Livestock Development with the support of the FAO. It now involves the operations of several cooperating agencies, in particular the French Ministry of Foreign Affairs, under the supervision of the Tanzanian authorities. Its field of activity involves the whole coffee/ banana belt of Arusha and Kilimanjaro regions and includes three mountain massifs and a total of 120,000 farms.

The objective of increasing dairy production is to improve knowledge of the functioning of livestock husbandry on small farms; identify the main constraints encountered in this area through the use of on-farm trials; design appropriate techniques to be transmitted to small holders; set up training programs for extension agents and extension campaigns for farmers; and set up a network of input suppliers for livestock through cooperatives.

Two guidelines were followed: the farm is to be considered as a whole, with livestock husbandry being considered as one activity related to all other elements of the production system, and no farm types were to be excluded from the dairy development scheme.

This last guideline made it necessary to characterize the different types of farms so as to propose appropriate techniques for the different production systems.

Two levels of analysis were emphasized in attempting to better understand the characteristics of the farms and the place of livestock husbandry: the farm considered as a whole, including agricultural production, the family living on the farm, and, when present, the hired labor as well; and the region as an entity in which complementary and/or contradictory processes occur. These include agroecologjcal complementarity between plain and mountain, connections between towns and country, relations between producers and consumers and links between farming and non-farming activities. These processes may be approached in terms of exchanges of products, of labor and of money.

A FARM TYPOLOGY, AS A RESULT OF A DEVELOPMENT PROJECT

Putting the Existing Model of Small Dairy Producers in Question

At the beginning of the program, we had a model of small dairy producers that was considered to be representative of the area. This was the typical small farm from which the family draws most of its resources and to which it dedicates the greater part of its activities. Such a farm owns some 0. 8 ha land in the highlands (coffee/banana) for a household of about five people and has one or two head of upgraded dairy cattle. At first we oriented our actions on the basis of this model.

A more detailed survey was done to determine the technical and economic characteristics of these farms. A random sample was taken from a list of farms drawn up by village authorities. These were interviewed monthly for a period of 18 months. These surveys provided information about the livestock systems, including such things as animal characteristics, herd structure, husbandry practices, animal performances and income and expenditure related to livestock.

Our purpose was not to isolate a livestock subsystem, but rather to apprehend the characteristics and the place of livestock husbandry in the farm. Therefore, a number of other criteria were taken into consideration such as family structure, the division of work on the farm, the role of women in livestock husbandry, farm structure and the extent of cash-crops. These surveys enabled us to make preliminary assessments of the main constraints facing these small dairy farmers, which were determined to be the following: (1) low level of cattle ration (including energy supply level), (2) difficulties in procuring inputs such as drugs, concentrates and acaricides and (3) problems of herd management, especially the raising of heifers and reproduction management. They also enabled us to confirm certain aspects of work organization on the farm, in particular the predominant role of women in livestock husbandry.

An initial finding of these surveys, then, was that the model of a small dairy farm in which all the family dedicates the major part of its activities to the farm did not conform to reality. Most of the families had activities outside the farm, and most of the farms had non-agricultural incomes.

A number of criteria appeared to be useful to differentiate among farms. These were the levels of income, facilities, whether or not they employed hired labor, farm size and level of farm input consumption. Some criteria that had been selected at the beginning, such as the sexual division of labor on the farm and animal performance, were shown not to be very important in establishing farm types.

Finally, we distinguished two types of farms, not on the basis of the technical characteristics of their production systems, but depending upon whether or not they were involved in a process of capital accumulation, whatever the sources of this accumulation. Thus, we find on the one hand farms in a process of capital accumulation including the purchase of land or of transport facilities such as pick-ups, and on the other hand farms that are-not reinvesting in the farm operation. This distinction corresponds clearly to two different types of farm functioning and, as a consequence, to different ways of involvement in development programs. In the one case, innovations requiring investments, for example a new cowshed, were easily accepted and even desired. In the other case only those innovations that involved little or no investment, such as improved herd management, were considered acceptable.

This first categorization helped us to understand the impact of development activities. However, it did not help us to understand important issues at the regional level. The classification of farms one uses in a region is pertinent only if it fits logically into the analysis of the regional socio-economic environment, that is to say that it fits logically in development processes considered synchronically (exchanges of products for instance) or diachronically (continuity in the evolutions). Several questions remained unanswered. For example, the milk marketing circuits at regional level presented a problem. The surveyed farms in the aggregate had a surplus of milk, but this surplus did not reach the towns where it could be sold for a good price. Another unanswered question related to zebu cows that, although they were a majority ten years earlier, seemed to have vanished, since very few participated in the development program. We tried to go deeper into these two aspects.

Farms with Zebus Are Not Marginal

Regional monographs and interviews that we carried out in the surveyed farms showed that zebus were numerous in the highlands until quite recently. However, given the development of artificial insemination and the presence of numerous up-graded dairy bulls in the villages, the assumption that the numbers of zebu owners was, in fact, greatly reduced could not be entirely excluded. A development activity conducted simultaneously with this enquiry enabled us to get a better picture of the situation.

Distribution centers for a molasses-urea mixture, which was processed in a sugar factory in the plain, were set up in 20 villages so that cattle owners might buy relatively small amounts, as little as 1 liter at a time, at reasonable prices. This operation was preceded by numerous discussions with the members of the village cooperative management committees, who were meant to take over the management of the distribution centers. During this process it became evident that zebu owners were, in fact, quite numerous but that they did not participate in dairy development activities. Although zebu cows are milked (they yield up to 5 liters a day during the first three lactation months), their owners did not believe that their performances could be improved. Thus, the livestock officers, who could visit only a small proportion of the total farms, seldom had occasion to meet them.

A change was then introduced into the development project, and emphasis was placed on the fact that extension operations should address all the farms with cows that were producing milk. A first follow-up showed that the production systems on farms with zebus were significantly different from the systems investigated previously.

Farms without Cattle

It was widely believed that almost every family consumed milk produced on their own farm. However, the surveyed small holders were selling milk, and this milk was sold not in the towns but "to the neighbors." What, then, was the farm structure of these neighbors who purchased milk? This was a major issue, as one of the objectives of the project was "to supply milk to urban areas." This objective was based on the assumption that rural areas were already well supplied and that there existed a surplus, which could be marketed in the towns.

Those in charge of the Regional Direction for Community Development, who were responsible for village-level coordination of all development activities, including health, education and agriculture, had especially stressed child malnutrition problems in some villages due to inadequate supplies of milk. They drew our attention to the great number of farms that had neither cattle nor small ruminants. Interviews carried out in the different districts confirmed the size of this farm category, in which the poorest families were to be found.

TYPOLOGY OF THE PRODUCTION SYSTEMS IN THE KILIMANJARO MASSIF

A study involving about 100 farms distributed along a transect from the forest to the plain confirmed these observations regarding the different kinds of production systems. After discussions with extension agents, we were able create a new typology of the Kilimanjaro production systems (Fig. 3), which was based upon four main criteria: (1) whether or not lowland fields were cultivated, (2) level of income from farm activities, (3) work force used on the farm for agricultural work and, finally (4) characteristics of the cattle.

Several criteria that are important in understanding the functioning of farms do not appear in the typology as they are non-discriminate, either because they are present more or less uniformly among several types (importance of female labor) or because they show gradients that do not allow the specification of clear limits between the different types of systems (proportion of non-agricultural monetary income, transport facilities). For this reason, they were ultimately not included in the criteria used for the typology.

Thus, after two and one-half years, we had a typology of production systems that helped explain how the agriculture of the region functions, at least with respect to key issues of development. For any farm visited randomly in the region, there corresponds a type, and each type shows considerable homogeneity with respect to its possible relationship to dairy production development activities.

This typology also helps clarify some aspects of the region's economic function by exposing relationships among different types of farms. Thus, types 1 and 2 provide agricultural labor to types 4, 5 and 6. In return, types 4 and 5 produce a surplus of food products that are purchased by the families in types 1 and 2 and that, of course, also go to supplying the town.

This typology was developed from 1984 to 1986. The last stage was made possible by crossing the qualitative data of the different types with the data from the general census of domestic stock, an enumeration of animals in all Tanzanian households by species, breed, sex and age, which was available only in 1986. By establishing a relation between these two approaches, we were able to confirm the importance of the zebu production system and of the category of farms with no cattle. This enabled us roughly to quantify the number of farms in each of the types.

A FARM TYPOLOGY AS DEVELOPMENT TOOL

This typology is not normative; its purpose is not to create new systems, nor to define types representing a norm that farms should strive to achieve. Its function is cognitive: to provide a representation of existing systems that facilitates identification of key properties of the system of interest in development work and to identify target groups. It may also help in anticipating the way a given innovation proposal might be received by a particular farm type. Therefore, it can produce project management decisions that are better adapted to specific project objectives.

Detecting the Limitations of the Program

One notices immediately that the poorest peasants are to be found in Group 1, i.e. the group with no cattle. From this, one may deduce that the objective of helping the poorest peasants by improving their dairy production is quite unrealistic, because they have no livestock. The introduction of livestock to these farms is not realistic because of their small labor force, their lack of capital and their small size. Other activities will have to be proposed to assist these families, such as the introduction of dairy goats, for example.

On the other hand, these families are directly affected by measures affecting milk marketing. They consume some of the milk surplus from the other types. Any milk policy or program that transfers surplus milk from the producer groups towards the towns without a marked increase in production would result in depriving a part of the rural population of its source of milk supply when the malnutrition observed in some villages shows that this supply is already insufficient.

Detecting Constraints in Each Type

By looking at the connections between the different farm types, one is able to detect exchanges not only of food products, but also of hired labor. Thus it appears that hired farm labor originates from farm types 1 and 2 where there are neither cattle nor zebu cows. As a consequence, these farm workers have no prior experience when they care for up-graded animals. Moreover, in type 6, the owners themselves have little livestock experience, since they are Public Service officers and shopkeepers. This partly accounts for the difficulties encountered when attempting to introduce new techniques to this group.

Using the Typology for a Specific Development Activity

This typology may be useful (1) to identify target groups for a given activity and evaluate its possible impact, (2) to better plan extension operations according to topics and (3) to help in choosing farms for multi-local trials.

Roughage treatment Given inadequacies in the feed available for the cattle, an effort was made to improve the quality of maize leaves and stalks brought from the lowlands to feed the cattle. A urea treatment was considered. A series of trials was set up in a network of farms on which treatment methods adapted to local conditions were tested. The treatment involved a three-week treatment of the roughage in small pits on the farm with urea fertilizer at *5%* urea on a dry matter basis. The pits were made air-tight with banana leaves. The treatment is quite easy to perform, but it requires approximately 5 hours of labor. This experiment was undertaken before the final typology had been developed. The typology gave some insight into several aspects.

During the follow-up of the experiment on the farms, a number of farmers complained that their cattle did not eat the treated forage. After further investigation, it was found that in most cases, the forage had not even been distributed to the animals or had been given in conditions quite different from those advised. On all these farms, it was the hired farm workers who actually did the additional work involved in treating the forage. These workers were not particularly interested in the success of the technique since increases in milk yields would not bring an increase in their salary, and they were not aware of its advantages, since the nutritional requirements of up-graded cows are quite foreign to them. Their employers, on the other hand, were often inexperienced and mostly absent from the farm and therefore could not redress the situation. Thus, in this case, the labor situation on the farm was the limiting factor.

A similar limitation occurs in type 3, in which the reduced work force impedes the introduction of techniques requiring work peaks.

The farms in type 2 do not generally have a plot in the lowlands and therefore cannot harvest maize stalks and leaves. Hence, only farmers in types 4 and 5, who cultivate land in the lowlands and who are able to mobilize adequate labor, are likely to be interested in this technique. With this information it was possible to quantify the potential impact of the technique, to identify the types of farmers who should be invited to extension meetings and to identify the type of farms on which it would be worth carrying out demonstrations.

Distribution of molasses-urea mixture. In contrast, the molasses-urea may fit into all production system types, not only in types 4 and 5, but also in type 2 as long as the mixture is cheap, and in types 6 and 3 because it results in a visible and rapid increase in milk yield without requiring additional labor, either hired (type 6) or from the family (type 3). Thus, livestock officers should insist that all farmers attend the extension meetings on molasses-urea mixture feeding. It also means that demonstrations should be organized among all farm types, so that each farmer can observe the technique on a farm with characteristics similar to his own.

Introduction of tropical legumes. On-farm trials were performed to develop ways of improving farm forage production by intercropping tropical legumes *(Desmodium incinatum, Desmodium incortum, Macroptilum artropurpureum, leucaena Peucocephale, etc.)*

with the improved grass already being grown around houses and on road sides. All farm types that have access to land are relevant (types 2, 3, 4, 5) even if they produce little grass. Farms for trials are chosen according to the typology, since results in one agroecological zone may not be transferable from one production system to another. This choice is crop-related to agroecological zones.

THE LIMITATIONS AND ADVANTAGES OF THE APPROACH

Developing the Typology

The adoption of an empirical approach in which the development of a typology results from continuous feed back processes between on-farm development activity and the analysis of regional agriculture does not involve a sophisticated methodology. The knowledge that extension officers already have allows rapid identification of issues that will guide the analyses, even if the information seems to be contradictory. The multiplicity of field activities and the presence of extension officers over the whole area provide a flexible network of information that can, at any moment, assist in confirming or repudiating an assumption.

The problems posed by setting up a reliable observation network are not entirely removed by this approach, but they are greatly reduced. In fact, the main objective is to initiate activities on a variety of complementary themes or issues and not to try to conceptualize a comprehensive information collection system. Consequently, methodological requirements are less stringent than in the case of an a priori approach that requires the detailed conceptualization of an information collection system in advance.

This approach offers a number of other advantages. On the one hand, it is easier to construct a typology specifically for development activities. The constraints encountered by extension agents and the aspects that they consider to be important can be given priority. The objective is not to accept their viewpoints, but to take them into account and, if necessary, to question them with the help of informed arguments. The ultimate probability of their adopting the typology is much higher if they have been associated with each phase of its construction. Finally, both the reflection that was involved in developing the typology and the discussions that led to revising the "representative model" provide an excellent training experience.

Some might question, however, whether it would not have been better to have developed the typology before beginning development activities so that these might be better focused from the outset. This does seem more logical, since target groups could have been identified in advance. However, it is not quite that simple. Without a preliminary empirical typology, one runs the risk of focusing upon a farm model that is only approximate or perhaps even quite unrepresentative of reality. The risk is obvious, and we could not avoid it. Perhaps even more importantly, if we had identified and quantified the different types at the very beginning, it is unlikely that the typology would have been adopted by extension agents. For example, the zebu owner group (type 2) might have been identified much earlier. However, to a significant extent it was the very fact that it was identified at the time it was, and in the way it was, that made it possible for the extension agents to incorporate this information into their activities. D. Norman shows that there is often a long interval between the diffusion of the results of systems research and the adoption of these results by extension and development services. Building the typology within the extension structure and function certainly slows down typology development, if only because it is associated with the questioning and rejection of the pre-existing representation of one or several farm models considered until then to be representative. However, because it is the joint product of an extension team, it will be implemented as soon as it is ready.

Implementation of the Typology

A typology of production systems provides a common representation of a region for all those involved in agricultural extension and development. Thus it serves as a frame of reference for discussions within the development program and for discussions among those who manage the program as well as for political and administrative authorities who set the parameters of agricultural policy. Such a typology shows the different types of production systems that exist. It facilitates the assessment, for each type, of the impact a technical activity will have upon the project's objectives. As such, it facilitates the assessment of the social interests that are involved in certain technical choices, since the importance ascribed to a particular target group within a project is, in fact, an agricultural policy decision and not a mere technical decision.

Although the usefulness of such a typology as an instrument of agricultural policy and as a guide for a project is evident, its value for more detailed, technical decision-making is far more limited. For instance, it is of little help in advisory or individual diagnosis activities. Within an individual type, the degree of technical command of a production system may vary greatly (in Group 5, there were cows giving from 5 to 20 liters of milk in their

Second month of lactation). In this example, however, the extension and development program did not intend one-to-one activities, since the program did not have enough resources for such an intensive approach.

Finally, a typology of production systems expresses only one aspect of regional diversity. The different types are distributed over a series of diverse agro-ecological areas. For certain operations, such as forage improvement, it would be essential to cross-relate typology and agro-ecological zoning.

CONCLUSION

Development services are frequently faced with the need to set up extension and development programs in areas with a large proportion of small holders. In order to be sure that all of the farms can be reached by the constraints in their production systems. A farm typology is one of the elements that contribute to making a coherent analysis of regional agriculture.

Devised as part of a development program, the typology of small holders of the Kilimanjaro and Arusha areas is a collective creation of a development and extension team. Its implementation shows that it is able to contribute guidelines for initiating specific interventions as well as for focusing the total project. In this respect it providers a real and valuable tool for agricultural policy.

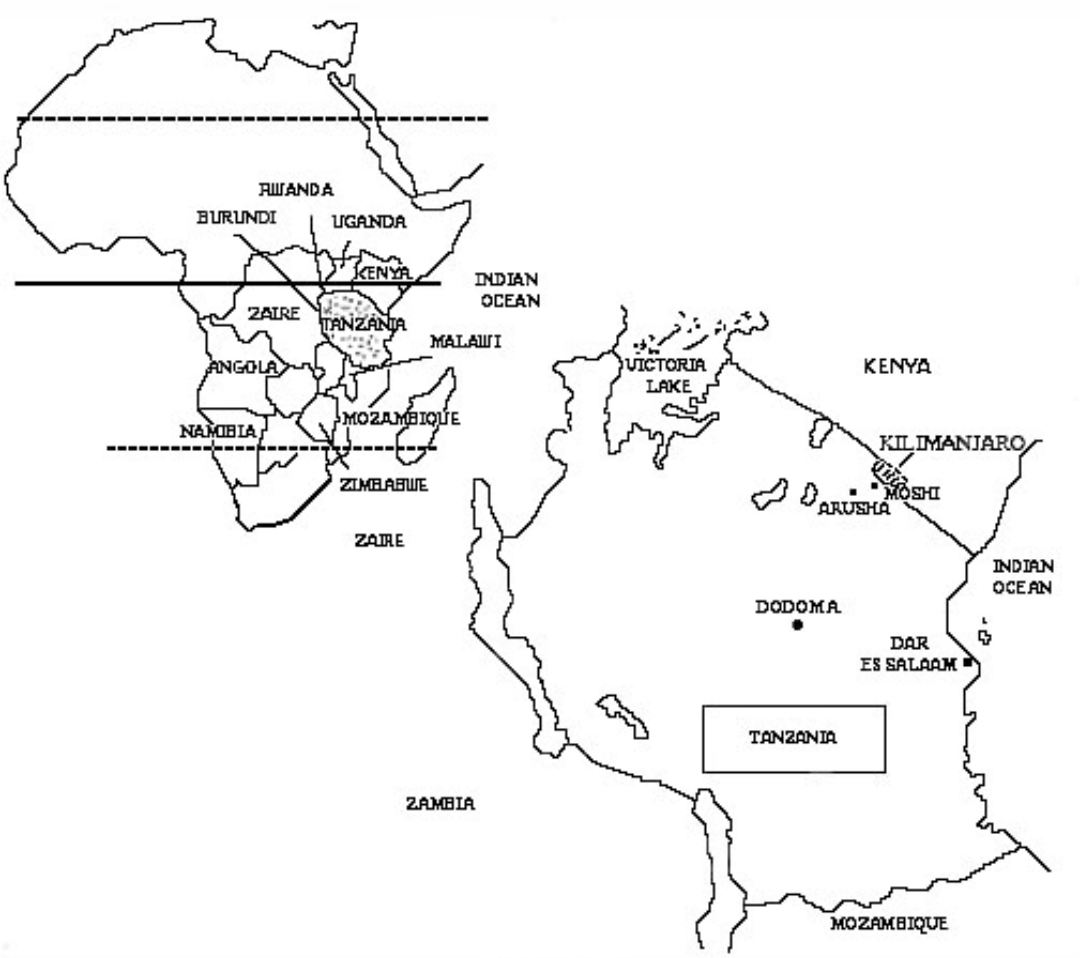

Fig. 1. Map of Area

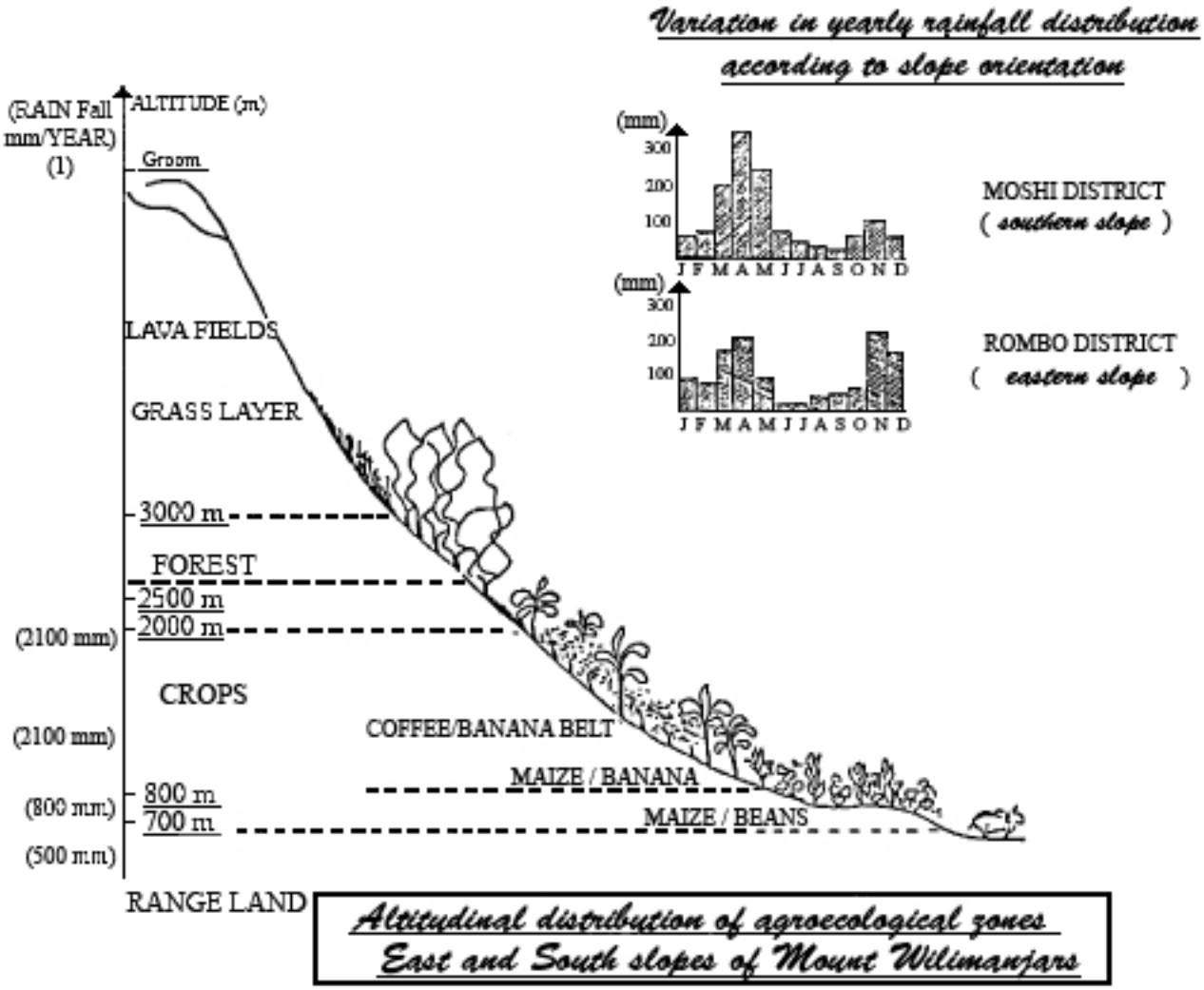

Fig 2. Altitudinal distribution of agroecological zones, east and south slopes of Mount Kilimanjaro.

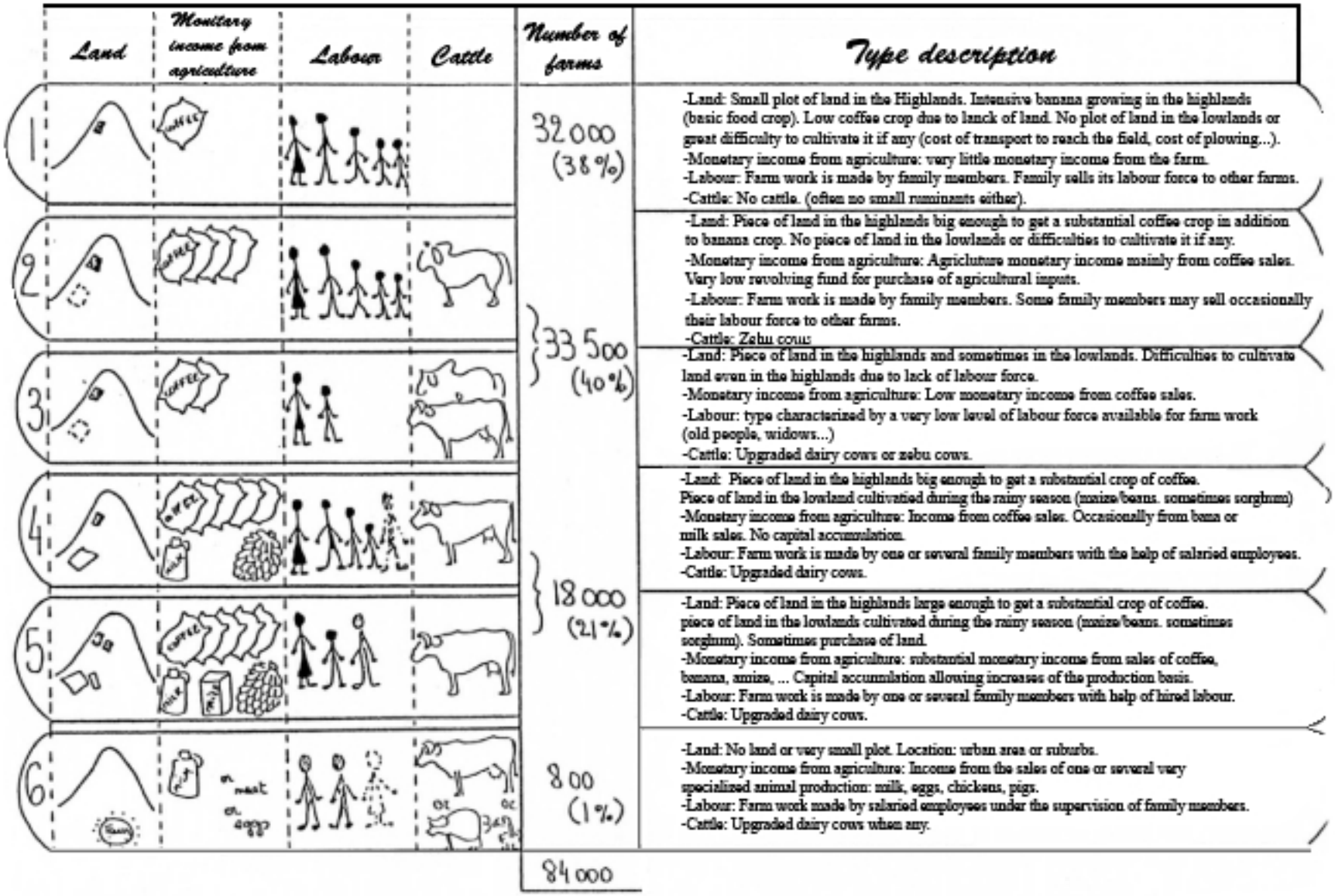

Figure 3. Typology of production systems of Mount Kilimanjaro.

ANNEX 1

SUMMARY OF THE MAIN ACTIVITIES CARRIED OUT BY THE DAIRY DEVELOPMENT PROGRAM.

This program was carried out, during the period of 1984 to 1987, by the Government's regional livestock services staff, which is made up of about 40 full time persons for both regions with the support of 4 foreign experts.

Several activities were carried out in order to meet the objectives of the program.

1. Better knowledge of farm functioning: Monitoring of a network of farms on particular topics, such as calf rearing, etc., was carried out by the field staff. Monthly surveys on a sample of 200 farms were carried out for 18 months, considering the total farm as the unit of analysis.
2. Working out appropriate techniques: On farm trials on several topics, such as tropical legumes, molasses-urea mixture feeding, record keeping system, calf feeding, etc., were carried out on a network of about 30 farms for each topic. The farms were chosen in relation to the typology and located in different districts and different agroecological zones.
3. Training for field staff: Members of the regional staff participated in the monitoring of trials and discussion with field staff. Training seminars were organized.
4. Extension campaigns for farmers: 714 seminars involving about 30,000 participants were organized between February 1987 and March 1988. Extension booklets prepared by the field staff were sold to farmers.
5. Setting up a network of input supply for livestock through cooperatives: A molasses-urea mixture processing unit and of a network of distribution centers in the villages (80 centers in 1988) were established. These were turned over to Cooperative-Unions after an 18-month period. Studies were carried out concerning the establishment of a specific "animal production department" in the cooperative Unions. Training seminars for village cooperative staff related to livestock husbandry inputs, including such topics as quality control, product utilization, etc, were organized.

ANNEX 2

DESCRIPTION OF CHARACTERISTICS OF LIVESTOCK HUSBANDRY

1. Average milk yield is low. Average yields are about 1350 liters per lactation for upgraded dairy cows, 400 liters for zebu cows after the calf has suckled. However great difference can be observed between farms.
2. These low performances are due mainly to feeding constraints. At certain periods of the year, the total dry matter fed to cows is not enough, and its quality is poor: a survey showed that weeds and grass collected along roadsides represent about 45% of the total dry matter provided to cows. Concentrates, such as cottonseed cake, wheat and maize bran, etc., are fed regularly in 40% of the farms.
3. Average intercalving period is long, 18 months, due to both poor feeding and reproduction husbandry.
4. Calf mortality before one year of age is about 12%.
5. General herd sanitary conditions are medium. There is almost no brucellosis or tuberculosis in the small holder sector, but periodic out-breaks of foot and mouth disease and tick-borne diseases can be seen when acaricides are not available in the markets. In spite of low milk yields, mastitis is an important problem.

CLASSIFICATION OF FARMERS INTO RECOMMENDATION DOMAINS

M. Moussie and C. Muhitira[1]

INTRODUCTION

In recent years FSR/E has widely been accepted by the National and International Agricultural Research Centers as a viable approach for agricultural research. What makes FSR/E different from the traditional commodity-oriented research is that farmers are an integral part of the research process in which researchers, extension staff and farmers jointly attempt to determine a research agenda. The Small Farming Systems Research project in Burundi (SFSR) conducted a diagnostic of the project area with full participation of the groups mentioned above (Moussie et al., 1987). In order to determine a research agenda, hence recommendation domains, farm households have to be classified into relatively homogenous groups based on cultural practices and socioeconomics characteristics.

Even though too much has been said about the need for grouping farmers, there has been little effort to arrive at empirically verifiable classifications. Byerlee et al. (1982) emphasized that FSR/E activities are most efficiently implemented for a group of farmers with roughly similar practices and circumstances for whom a given recommendation will be appropriate. These groups of farmers with relatively similar circumstances are often called Recommendation Domains, a terminology developed by the CIMMYT Economics Staff. Collinson (1983) defined Recommendation Domains as a stratification of farmers in which variations between groups are maximized and variations within are minimized. Such types of stratification will be achieved using statistical analysis based on quantitative data. While Sondeos are one of the major tools for understanding the farming systems of an area, they may not be the most efficient tool for classifying farmers in the true statistical sense. Hilderbrand and Ruano (1982) suggested that Sondeos should be followed up by quantitative research to easily determine homogenous groups as a result of in-depth formal survey and analysis.

This paper attempts to classify farmers into relatively homogenous groups using Cluster and Discriminant statistical analysis. Based on qualitative results of the Sondeo, an in-depth formal survey was conducted from which key variables were selected to determine the Discriminant Function. Using this function, a combination of these independent variables is formed to serve as the basis for classifying farmers into clusters. In addition, discriminant analysis identifies variables that are important for distinguishing the groups. Once these variables are determined, one can predict group membership for farmers who were not included in the survey.

METHODOLOGY

Following the diagnostic, a formal verification survey was conducted in the SFSR project zone of Karuzi province, Burundi, during the second cropping season of 1987/88. Data on household characteristics, farm input/output, cultural practices and socioeconomic characteristics were collected from 335 heads of farm households. A multi-stage random sampling method was used in which 67 sub-villages were randomly selected in proportion to the population ratio of the Collines[2] of which they are part. The project area is composed of 25 Collines. Each Colline is represented by at least one sub-village from which 5 farm households are randomly selected for the survey. Where the population is high, Collines are represented by 3 or 4 villages (15 to 20 farm households).

The variables selected for classification are a mix of farm household factors, including input use (seeds, fertilizer and labor), farm output (revenue, coffee production), cultural practices (raising goats) and socioeconomic characteristics (reading ability, part-time work). These variables are assumed to produce a discriminant function such that the estimated coefficients would result in the 'best' separation between groups.

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[2] A colline is a basic administrative unit composed of households and fields scattered over a hillside that is often delimited by marshy lowlands or other recognizable geographic boundaries.

The discriminant function is expressed as:

$$D = B_0 + B_1X_1 + B_2X_2 + ... + B_nX_n.$$

Where D is the estimated value of the discriminant,
the X's are the values of the independent variables, and
the B's are the estimated coefficients of the X variables.

The method used to group the farmers is Agglomerative hierarchical clustering in which 335 steps were used to classify all farmers into the corresponding cluster groups on the basis of the determinant variables listed in Table 1.

These variables may be categorized as structural and strategic determinants. The former deals with variables that circumscribe opportunity, while the latter relate to variable inputs directly related to production.

RESULTS AND DISCUSSION

The result of the classification is shown in Table 2. As presented in the table, the farmers are classified into 4 groups: 130 in group 1 (38.8%), 79 in group 2 (23.6%), 50 in group 3 (14.9%) and 76 in group 4 (22.7%). The same table shows the percentage of cases correctly classified in each group. For example, all 130 farmers were correctly classified in group 1. Of 79 farmers in group 2, 77 were predicted correctly to be classified in that group (97.5%). In group 3, 33 out of 50 (66%) were assigned correctly, while in group 4, 75 out of 76 farmers (98.7%) were predicted correctly to be in that group. The overall percentage of farmers classified correctly is 94.03% (315 out of 335).

Table 3 shows the differences in group means and standard deviations for each variable in each cluster. In cluster 1, for example, 32% of the farmers can read Kirundi, no one has a second job that can generate some revenue, and only 20% hire some labor during peak season. They have an average of 147 producing coffee trees and buy an average of 4.8 kg of fertilizer per household. They all said that they often buy seeds from the market, and 90% of them experience frequent shortages in beans, the most important staple food of Burundi. In contrast, cluster 3 shows a higher percentage of reading ability (68%), more coffee trees (307), 32.4 kg of fertilizer. Only 10% of the farmers said that they sometimes do not have adequate quantity of beans for consumption. Farmers in group 3 raise an average of 4.2 goats compared to less than 2 for the other 3 groups. The average total revenue in cluster 3 is more than three times than that of clusters 1 and 4. It is, therefore, logical to see in Table 3 that 80% of the farmers in group 3 hire labor during peak season.

There are some similarities in groups 3 and 4 except for variables SEMENCES (seeds) and HAR.PEN (shortage in beans). In group 2, 97% of the farmers engage in part-time activity that may generate some additional income. Their average total revenue is higher than groups 1 and 4 by about 6000 Burundi Francs.

Table 4 shows significance tests for the equality of group means for each variable. The *Wilks' lambda***,** which is shown in the table, is the ratio of the within-groups sum of squares to the total sum of squares. Large values of *lambda* (closer to 1) indicate that group means do not appear to be different, while small values relate to variable means that significantly differ between groups. It can be seen from Table 4 that variables such as ACTIVITE SECONDAIRE, SEMENCES and HARICOT PENURI show small values of lambda, which means that the group means are most different for most of the groups. Since there is no cutting edge to differentiate which lambda is small or large, the *Wilks' lambda* is supplemented by the F. Ratio whose values show whether the hypothesis that all group means are equal is rejected or accepted. As shown in Table 4, the F values are seen with significance level of less than .0001 in each of the variables. This shows that the group means listed in Table 3 are significantly different in two or more groups.

The coefficients of the nine variables (Bi) and the constant (Bo) are listed in Table 5. Three coefficients are seen for each of the variables. Coefficients listed under Function 1 are considered the best estimates since the percentage of variance among the group means is the highest (56%) compared to 33 and 10% for Function 2 and 3, respectively.

Based on Function 1 coefficients, the discriminant score (D) for each case (farmer) is calculated. For example, the D score for farmer 1 is calculated as:

$$D1 = .126215(1) + 5.0885(0) - .0009366(300) + .001704(20) + 1.2901189(1) + .1131097(1) + .0573065(4) + .0000065(33800) - 2.082462 = -.7875$$

Numbers in parenthesis are values of variables for the first farmer in the survey data.

For farmers to be classified into different groups, the respective D scores must be significantly different. For example, the D score for farmer 2 is 4.2728 compared to -.7875 and -1.1483 for farmers 1 and 3, respectively. Farmer 1 and farmer 2 are classified in group 1, while farmer 2 is assigned to group 2.

Table 6 shows how each variable is correlated to a function. For example, ACT-SECOND has the highest correlation with discriminant Function 1. This variable may be considered as the most important variable in terms of classifying variables for classification. If we look each variable separately, the variable LIR-KIR (reading ability) is the least important factor for grouping farmers into relatively homogenous groups.

Table 7 shows estimated coefficients for each variable by cluster. In this table, the relative importance of each variable in each cluster is shown. For example, variable ACT-SECOND has more weight in cluster 2 than the rest of the clusters, while variable SEMENCES is least important in cluster 4 compared to the other clusters.

In Table 8, the correlation matrix of the predictor variables is presented to see if there are some inter-dependencies that may possibly affect the interpretation of the discriminant analysis. If some variables are highly correlated, it will be difficult to determine which variable has more weight to which function and cluster. High correlation could also affect the classification results by reducing the percentage of farmers correctly classified. As shown in the table, no significance correlation is seen among the variables.

SUMMARY AND CONCLUSION

Using predictor variables, a researcher can objectively classify farmers into recommendation domains. Farmers can be classified correctly if the determinant variables are composed of farmers' cultural practices, farm input/output and socioeconomic characteristics. In this paper it is shown that farmers are grouped into 4 distinct groups based on the above determinants. By comparing and analyzing each variable in each group, a researcher can determine his/her research agenda. For example, a more input-intensive research program can be proposed for farmers in group 3, which have more income, buy more fertilizer, grow more coffee and mostly hire farm labor. For policy makers, this kind of information is important to develop a relevant agricultural policy.

As a result of cluster and discriminant analysis, the estimated coefficients of the predictor variables can also be used to classify new farmers into any of the groups. If the variables are well selected, these new farmers can not only be from the same region where the initial survey was done, but can also be from other regions. Finally, the use of discriminant analysis provides indications of which variables are the most important in classifying farmers into recommendations domains.

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Table 1. **Variables (Xs) included for the analysis**

Variable name	Description
LIR-KIR	ability of reading Kirundi, 0=no, l=yes
ACT-SEC	part-time work (other activity), 0=no, l=yes
MAIND-SAL	often hires labor, 0=no, l=yes
PROD-CAFE	number of producing coffee trees
KG-ENG-CH	amount of fertilizer bought in Kilograms.
SEMENCES	often buys seeds from market, 0=no, l=yes
HAR-PEN	shortage of haricot frequented, 0=no, l=yes
CHEVRES	number of goats in the household
REVENU	this year's estimated total revenue in B. Franc

Table 2. Classification Results with Percent of grouped cases correctly classified

ACTUAL GROUP	# of cases	%	PREDICTED GROUP MEMBERSHIP			
			1	2	3	4
Group 1	130	38.8%	130 100%	0 .0%	0 .0%	0 .0%
Group 2	79	23.6%	1 1.3%	77 97.5%	0 .0%	1 1.3%
Group 3	50	14.9%	4 8.0%	5 10.0%	33 66.0%	8 16.0%
Group 4	76	22.7%	0 .0%	1 1.3%	0 .0%	75 98.7%

Percent of all cases correctly classified = 94.03%

Table 3. GROUP MEANS & STD. DEVIATIONS
By CLUSTER & VARIABLE

1. GROUP MEANS

VARIABLE	CLUSTER 1 N=130	CLUSTER 2 N=79	CLUSTER 3 N=50	CLUSTER 4 N=76	ALL CASES N=335
LIRE KIR. (0,1)	.32	.56	.68	.17	.39
ACT. SEC. (0,1)	.00	.97	.26	.01	.27
MAIND. SAL (0,1)	.20	.43	.80	.29	.36
PROD. CAFE	147	121	307	132	161
KG. ENG. CH.	4.80	6.60	32.40	5.40	9.50
SEMENCES (0,1)	1.00	0.80	0.28	0.00	0.62
HAR. PENU (0,1)	0.90	0.77	0.10	0.11	0.57
CHEVRES	1.50	1.70	4.20	1.50	2.00
REVENU (Frbu)	20056	25845	69610	19550	28703

2. STD. DEVIATIONS

VARIABLE	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4	ALL
LIRE KIR.	.46	.50	.47	.37	.48
ACT. SEC.	.00	.15	.44	.11	.44
MAIND. SAL	.40	.49	.40	.45	.48
PROD. CAFE	126.90	86.80	330.30	97.50	173.00
KG. ENG. CH	8.30	12.10	35.50	10.80	19.11
SEMENCES	.00	.40	.45	.00	.48
HAR. PENU	.30	.42	.30	.30	.49
CHEVRES	1.76	2.29	3.91	1.62	2.48
REVENU	21850	18926	89125	16646	42381

Table 4. Tests for Univariate Equality of Group Means
"WILKS' LAMBDA" & F. Radio

VARIABLE	WILKS' LAMBDA	F-HAT10 (3,331)	SIGNIFICANCE
LIRE KIRUNDI	.86537	17.17	.0000
ACTIVITE SECONDAIRE	.18944	472.10	.0000
MAIND'OUVRE SALAIRE	.82246	23.82	.0000
CAFE EN PRODUCTION	.87232	16.15	.0000
KG - ENGRAIS	.74660	37.45	.0000
SEMENCES	.28877	271.70	.0000
HARICOT PENURI	.45379	132.80	.0000
CHEVRES	.85547	18.64	.0000
REVENU	.83265	22.18	.0000

Table 5. Unstandardized Canonical Discriminant Function Coefficients

VARIABLE		FUNCTION 1	FUNCTION 2	FUNCTION 3
LIRE- KIR.	(x1)	.126215	.019794	.967355
ACT. SEC	(x2)	5.088500	-1.616124	-.607108
MAIND - SAL.	(x3)	- .008884	-.490976	.133861
PROD–CAFE	(x4)	- .000936	-.000822	.001962
KG. ENG-CH	(x5)	.001704	-.012018	.029405
SEMENCES	(x6)	1.290189	2.864937	1.625976
HAR- PENU	(x7)	.113109	.966611	-.533113
CHEVRES	(x8)	.057306	.029614	.260349
REVENU	(x9)	.000006	.000006	.000008
CONSTANT		-2.082462	-1.478012	2.327867

Canonical Discriminant Functions
Percentage of Variance

Fcn.	Eigenvalue	% of Var.	Cum. %	Canonical. Corr.	After Fcn.	Wilks' Lambda	Chi Square	Sign
					0	.0214	1259.1	.0000
1	5.0063	55.92	55.92	.913	1	.1285	671.9	.0000
2	3.0025	33.54	89.45	.866	2	.5143	212.7	.0000
3	.9443	10.55	100.00	.697				

Table 6. Pooled within groups Correlations between Discriminating Variables & Canonical Discrimination Functions (Variables ordered by size of correlation within Functions)

VARIABLE	Function 1	Function 2	Function 2
ACT -SECOND	.89046*	-.32024	-.03528
SEMENCES	.29243	.80326*	.32145
HAR-PENU	.21559	.56856*	.02057
KG-ENG-CH	.02036	.18494	.49848*
REVENU	.00007	.13882	.38932*
CHEVRES	-.01516	-12383	.35908*
PROD-CAFE	-.04328	-08690	.34793*
MAIN-SAL	.04637	.18893	.32202*
LIRE-KIR	.11082	-.06228	.29547*

Table 7. Classified Function Coefficients (Fisher's Linear Discriminant Functions)

VARIABLE	CLUSTER 1	CLUSTER 2	CLUSTER 3	CLUSTER 4
LIRE-KIR	2.678051	2.739514	4.340613	1.124316
ACT-SECOND	-.929120	27.341700	5.082593	-.787156
MAIND-SAL	-.756522	.349506	1.524204	.898263
PROD-CAFE	.009022	.001593	.009053	.004530
KG-ENG-CH	.015729	.038780	.118577	.018213
SEMENCES	14.278470	12.453000	5.381106	-.275789
HAR-PEN	4.100483	2.508260	.866133	1.083138
CHEVRES	.716960	.929886	1.311438	.397994
REVENU	.000012	-.000030	.000031	.000009
Constant	11.404550	22.144290	12.512730	2.500145

Table 8. Pooled Within – groups Correlation Matrix

	LIRE-KIR	ACT-SECON	MAIND-SAL	PROD-CAFE	KG-ENG-CH	SEMEN.	HAR-PENU	CHEV.	REVENU
LIRE-KIR	1.00000								
ACT-SECON	.10525	1.00000							
MAIND-SAL	.08879	.07672	1.00000						
PROD-CAFE	-.03348	.20128	.16496	1.00000					
KC-ENG-CH	-.03863	-03461	.17033	.10015	1.00000				
SEMENCES	.04046	.00266	.12276	.05842	.05296	1.00000			
HAR.PENU	.04641	.09890	.04166	.01640	.05464	.40981	1.00000		
CHEVRES	.18397	-13320	-.03125	.08103	.06623	-.15600	-.11077	1.00000	
REVENU	.07419	.23949	.18598	.24327	.00279	.18486	.17192	-.16919	1.00000

MANAGING FARMER SELECTION FOR MORE EFFECTIVE FSR&E

Alistair J. Sutherland[1]

FARMER SELECTION IS IMPORTANT

Small-scale farmers are the primary client group for farming systems research (FSR) activities. The majority are resource-poor farmers who are severely handicapped in taking their problems to research scientists. Small- scale farmers live in rural communities. These communities have influential members, sometimes called "brokers," who tend to monopolize relations with representatives of the "outside world," such as development project officials and FSR teams. Brokers often benefit the community, especially when they can mobilize local support and lobby outside the community for assistance for local projects (such as self help schools, clinics, dams, etc.). However, brokers also have their own interests to serve, and when it comes to agricultural technology, their requirements and interests are likely to differ from the interests of the community at large. Unless FSR team members take definite precautions, there is a high probability that most of their dealings with farmers will be directed through local brokers. The danger is that the FSR team may end up serving the interests of a small group of unrepresentative farmers at the expense of the larger, intended target group. For this reason it is important that careful attention be paid when selecting which farmers to communicate with during FSR activities. Farmers who are selected become, in effect, "spokesmen/women" for a particular target group.

This paper deals with three main issues: a) the more general issue of bias in farmer selection, b) purposive sampling and selection as a means of reducing bias and easing logistics and c) a particular approach to the selection of farmers for on-farm trials, the "community approach," with an example from Zambia.

The three issues are discussed within the context of FSR procedures, from target group identification through diagnosis and experimentation to recommendation release (CIMMYT, 1980). However, particular attention is paid to selection for informal survey and on-farm experimentation because these two procedures are not only the most powerful and widely used tools of FSR, but also those at highest risk of bias during farmer selection.

TYPES OF BIAS INFLUENCING FARMER SELECTION

Farmer selection for FSR activities cannot be done at random like picking names out of hat. In real field situations, a number of biases influence both the selection process and subsequent communication with those selected. It is not possible, or necessarily desirable, to avoid all of these biases. But it is important to recognize that the biases exist and take action if necessary. The benefit of understanding biases and managing them is to give the FSR team greater control over the collection and interpretation of on-farm data.

Taking action requires identification of the main sources of bias. Sources of bias can be classified into three basic kinds: bias arising through the use of middlemen; bias arising from the FSR team's internal characteristics, and biases arising from common logistical constraints. In addition biases also arise from particular local circumstances.

Middlemen

Common biases arising from the use of middlemen are extension bias, local political bias and family head bias. Agricultural extension staff (both field staff and specialists) often pay more attention to progressive farmers, cash croppers/credit receivers and friends. Local leaders and "brokers" often favor their own interest group and relatives while heads of households/household groupings may present their individual interests of subordinate households and family members.

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FSR Team Characteristics

Biases commonly arising from the FSR team's internal characteristics include gender bias, language bias, hospitality bias and innovator bias. When the FSR team is male dominated, there is often a bias towards male farmers as spokesmen and key informants. When team members don't speak the local language, want information fast, or don't trust interpreters, there is a bias to farmers who are articulate in the language of the research team (irrespective of the technical knowledge of the farmer). The team or its guide may value farmers who are able to provide food and comforts for visitors. When major changes in technology are being considered, or if a team holds a model of new technology trickling down from the more to the less progressive, there is often a bias to more innovative and progressive farmers. Finally, bias within the team may arise from its members' preconceptions, inappropriate definitions or the very lack of definitions of what constitutes a farmer and a household.

Logistical Factors

The most difficult biases to avoid often arise from logistical constraints. Bias for farming communities near roads and administrative centers is very common, especially when roads are poor, time is scarce, the program is ambitious, transport resources are limited and support staff are seconded from existing institutions. Logistical constraints relating to the management of trials also tend to bias a team towards working with the most progressive and cooperative farmers who have more resources for timely cultural practices. The desire to maintain a degree of continuity by using the same farmers over several seasons may also arise more often when logistics are limiting or farmer cooperation is poor. This strategy has the risk of bias in that this group of farmers, even if representative when selected, may have become a unique group due to a team's interventions.

Local circumstances

Other biases arise from the local circumstances that vary along with ecology, geography and social structure. For example, seasonal bias is common in single-season cropping systems when surveys and farmer selections are carried out during the dry season. In communities where some household heads are highly mobile while others are usually at home, there is a bias to "home centered farmers." In societies in which public meetings are a popular form of introducing outsiders such as farming systems teams, a bias results from the fact that only certain types of people/farmers may attend such meetings. Where there is a highly dispersed settlement pattern, there may be a bias to farmers living in clusters. In communities that are particularly suspicious of outsiders, there will be a bias towards "volunteer" farmers (especially when quick cooperation is a high priority), who may be marginal members of the community.

Having outlined the major sources and types of bias, the next step is to suggest ways of dealing with these biases. The suggestions below arise largely from experiences in Zambia, but it is anticipated that they will be applicable elsewhere, especially within Africa.

FARMER SELECTION DURING ZONING

During zoning, the identification of target groups, or recommendation domains, may be improved by interviewing a small number of farmers to reduce the bias of information provided by extension staff and local leaders. Such farmers are used as "key informants"; they are requested to provide a general map of the farming system in their local area and explain how it differs from adjacent areas. Other ways to minimize bias during zoning include the following suggestions:

- preselect agricultural extension workers for interview who have at least five years experience in the area under study,
- select local leaders who have lived in an area for ten years or more, and concentrate on older leaders with traditional authority in the area;
- select local villagers without office who were born in an area and are 45 or more years of age; ensure that older women are interviewed in preference to older men as the other informants are likely to be men; conduct interviews in the local language, with the aid of an interpreter if necessary; this will help avoid selecting more literate and traveled members of the local community;
- if a range of ethnic groups occupy the area being covered, ensure that informants are representative of the different groups.

SAMPLE SELECTION FOR INFORMAL SURVEY

During informal surveys, farmers interviewed are the principal spokesmen and spokeswomen for target groups identified during the zoning of farming systems. As such they ought to represent a cross-section of the target group under investigation, each presenting their own specific farming practices and views of agriculture related problems. In total, their views provide the main foundation for listing and prioritizing research problems.

Because informal surveys are informal, without the rigor of sampling procedures associated with formal surveys, there is a great danger that many biases will influence the selection of informants. The following precautions can reduce bias.

- Ensure that the team always selects farmers other than those first identified by middle men. If the local extension agent has a sketch map of his area and a list of farmers, this can be utilized as a basis for identifying a suitable area and also farmers to interview. In Zambia it is often necessary to tell the extension agent which area and farmers the team wants to visit and also to emphasize that the team is not only concerned with the "better farmers." When going through local political leaders, it is usually "politic" to interview and visit the field of the leader as a means to ensuring smoother cooperation and greater control of subsequent selection. Local middlemen can be used as providers of information and to introduce the team to farmers suggested by the team, rather than by the middlemen.
- When selecting heads of household for interview, it is important to be aware of the local kinship and residential organization. For example, interviewing only the family head in situations in which residential groupings are based on extended families may not be enough. It is better to interview all adults in the residential grouping than to single out only one and then move onto another residential group to do the same, and so on. Having women on the survey team can more easily facilitate the interview of women within the household. Younger household members may be interviewed more casually during visits to the fields or as the team departs to the next household.
- To avoid relying on male farmers as the main informants, a purposive strategy for including females in the dialogue often has to be devised. Having a woman on the team is often a big advantage. In Zambia, women being busy people, they will often stand up and leave in the middle of an interview. Therefore, it is advisable to ask questions directly relating to women's activities/knowledge early in the interview.
- Observe when the more articulate farmers come forward and select themselves. While such farmers are valuable informants, their opinion is no more important than that of a quiet or reticent farmer. Indeed, silence on an issue under discussion may indicate that it is either a non-issue for the farmer or a sensitive topic. Also farmers who volunteer themselves for an interview may often have motives other than to be helpful. Commonly in Zambia, farmers assume that the team is not simply seeking information but providing resources such as credit or inputs.
- Try to minimize language biases by ensuring that there are a sufficient number of people on the interview team who speak the local language well and also that those who don't are prepared to make an effort to learn and record relevant indigenous knowledge in the local language.
- Be aware of seasonal bias in the timing of the survey that can give rise to finding different people at home at different times of the year. For example in Northern Zambia shifting cultivation systems are combined with permanent villages near semi-permanent cultivation sites. If the village is surveyed during peak periods in the shifting cultivation system, there is an in-built bias to farmers doing more semi-permanent cultivation.
- Take note that seasonal bias can also influence the quality of information gathered on particular aspects of crop and animal management. This is the experience in Zambia when surveys are carried out during the off-season when the operations under investigation are not being carried out and there is no means of corroborating informants' statements. This bias can be reduced by supplementing an informal survey with on-farm monitoring (agronomic and livestock) of key operations during the season and also by trying to conduct more surveys when crops are in the ground.
- Notice how the time of day is likely to influence who will be at home, especially whether men or women will be at home. A prior understanding of the daily routine for both sexes at different times of the year will enable the team to avoid such bias.
- To avoid roadside bias, it is important to make the extra effort to interview some farmers staying further from the roads and service centers and establish in what ways their priorities differ, if any, from farmers

staying close by. It is also useful to estimate the proportion of the farmers in the target group living more than a given distance from main roads and service centers. Aerial photographs can be used for this. If very substantial proportions appear, it may be necessary to establish some on-farm trials in a more remote area.

SAMPLE SELECTION FOR FORMAL SURVEY

Farmers selected for a formal survey are spokesmen in relation to a set of issues identified during the informal survey. Rather than assist with identifying problems, they are expected to assist in quantifying the scale of problems and further pinpointing their causes.

A formal survey is a highly structured activity within FSR with considerable scope for controlling bias in selection. At the same time, achieving complete randomness in selecting a sample for formal survey is extremely difficult, laborious and costly in time and resources. Lists of farmers, if available, are rarely complete and often have biases. However, a purposive sampling approach can effectively solve many problems associated with logistics and variability within the target group. In Zambia three basic steps or stages are required to select a survey sample that is reasonably representative and accessible: selecting a target area, selecting target villages/settlements and selecting households. These steps are described in detail elsewhere (Sutherland, 1986).

The early CIMMYT approach (CIMMYT, 1980) did not include farmers as an important part of the "pre-screening process" of debating and sifting through problems and related technical solutions in order to come up with an on-farm research program. There was real danger that the farmers' role was limited to providing information, trial sites and labor. The farmer was not effectively incorporated as a collaborator with a decision-making role in the on-farm research process. The farmers only key decision was the same silent one that existed before FSR was initiated: that of adoption or non-adoption of a new technology.

Discussion at the community level prior to trial implementation permits farmers to be actively involved in the content of on-farm trials and trial design and to react to ideas, being tested in the trials. Farmers, whose reactions are effectively gauged and responded to with necessary adjustments, will better identify with the on-farm trials and the problems being addressed.

Selecting farmers for pre-trial discussions involves the incorporation of a more participatory approach within FSR. More time will be needed for identifying local farmer groups and informal associations and for organizing the meetings. If the formal survey has been conducted in a small number of villages, the same villages can be used to organize discussions about research possibilities.

Selecting farmers for such discussions requires sensitivity to local patterns of public discussion. For example, if men generally discuss matters of public concern as a group apart from women, separate meetings may be required to get discussion and feedback from both sexes. For example, the Chewa of Eastern Zambia have a traditional male forum (mphala) that can be used to obtain male opinion. However, if public meetings are generally associated with a lot of ceremony and oratory and technical issues are to be discussed, it may be advisable to hold small, informal meetings with three or four farmers rather than try to discuss details in a group of 20 or more adults. Where the train and visit (T&V) extension system operates, it may be possible to use T&V groups as an easily accessible forum for discussion.

A COMMUNITY APPROACH TO SELECTION FOR ON-FARM TRIALS

FSR approaches conventionally focus on individual farmers rather than on communities (Beknke and Kerven, 1983). The concept of a target group or recommendation domain, fundamental to the FSR approach, refers to a broadly homogenous category of farmers. No references or assumptions are made regarding relations between farmers within a target group or between different target groups staying in the same geographical area.

In reality all small-scale farmers live in communities. These communities are rarely homogenous groupings and are often characterized by significant internal differentiation. Common differences relate to ownership and access to property, quality of land held, gender and age of household leaders, stage in household developmental cycles, ethnicity, length of residence and extent of connections outside the local community. Such differences are usually inter-related and have a critical bearing on household resource allocation and decision-making on the farm. Many important farming decisions are not made by individual households, or household heads, acting alone. Negotiations between relatives and neighbors are built into agricultural decision-making in rural communities. The community approach seeks to increase the FSR teams'

Before proceeding to discuss farmer selection for trials, it should be noted that the community approach does not usually seek to replace the concept of target groups, although in certain circumstances this might be an option (Sutherland, 1984). Rather, it seeks to incorporate household linkages and related sociological variables into the diagnosis of problems generally and in particular into the testing and evaluation of technical solutions on-farm.

Selecting Farmers within a Community Framework

On-farm trials provide an opportunity for selected "farmer cooperators" to become spokesmen with the role of evaluating the relevance of the technology under test for themselves. The farmer as trial cooperator has the greatest *potential* influence on the refinement of research problems and the reassessment of research priorities. I stress the word *potential* because, as already mentioned, it is possible for farmers to have a passive role, to serve as providers of land and labor only.

The main argument here is that a comparatively small amount of time invested in more rigorous methods of farmer selection can pay dividends in improving the quality and manageability of on-farm trial programs. This advantage is additional to the increased understanding of the farming system provided through the community approach.

In Zambia until recently, and I suspect in many other countries also, two very common approaches were used in selecting farmers for trials. The first, and most common, was to leave selection up to the local extension staff and trials assistant. Unless very closely supervised, this approach introduced the kinds of biases listed earlier. The second common approach, especially when working in a new area, was to call a meeting of farmers and ask for volunteers. This also gave rise to similar biases and, in addition, often led to trial sites being widely scattered over a target area. Delegating selection to junior staff and using public meetings have proved quick methods of selection, but in the long run this approach has cost in travel time, transport resources and incomplete coverage of trials.

The selection of farmers for on-farm trials can follow the same purposive sampling approach as selection for surveys and prescreening discussions, but in a smaller geographical area. A smaller area allows for a community perspective to be built into the management and evaluation of on-farm trials. A smaller area is acceptable because previous stages have ensured that selected areas are representative. The task can be conveniently divided into the following steps: choosing a target area; defining the local community, defining the household; dealing with inter- and intra-household linkages and matching households with trials. Most of these steps may have already been followed during the preparation for formal and informal surveys. Nevertheless, in order to illustrate adoption of the community approach after diagnostic surveys and trials have been conducted, I outline each stage briefly before providing an example of implementing the community approach to farmer selection in Zambia.

Choosing a Target Area

A target area is an area within a recommendation domain where diagnostic surveys and on-farm trials are focused. The assumption is that the domain is broadly homogenous so that the FSR team need concentrate activities only within one target area. However, before planting trials it is necessary to look closely at how representative the target area is, particularly in relation to the objectives of the trials planned. For example, if a herbicide trial is planned for weed control, it will be necessary to ascertain if the weeds common in the target area are also common throughout the domain and that weeding is a widespread rather than a localized problem.

Zambia has experienced a common bias in selecting target areas, that of selecting areas close to main roads and choosing agricultural camps where housing is available for trials assistants. These are sometimes unavoidable logistical biases, but it is important to ensure that crosschecks are made before the final choice is made.

Defining the Local Community

Having selected the target area, if there has not already been a study, there is a need to make a quick study of the local community structure. The main local political and residential groupings need to be defined, both in general terms, and in the way they influence land-use and access to resources. In Zambia there is considerable variation in local political and residential groupings, so each recommendation domain will require a separate study of these groupings.

Once the local community structure has been described, the selection of a population to work with becomes easier. A village list is an essential starting point to selecting households. If a list has already been complied

during diagnostic surveys, the main characteristics of these residential groupings should then be listed, e.g. approximate size, main soil types, main crops, importance of livestock. The proximity of villages to the house of the trials assistant should also be recorded. Using this list, it may be possible to eliminate some of the residential groupings due to such factors as difficult access during the rains, inappropriate soils or minor importance of the crop/technology being researched in the trials.

Defining the Household

The main purpose of defining a household is to arrive at an agreed upon unit of analysis and interaction for data collection and the planning of on-farm trials. While many social surveys use the unit of consumption—"eating out of the same pot"--as a basis for definition, the unit of production is often more useful when FSR activities are production focused. If the intervention is concerned with livestock, then yet another basis for defining households, based on the main unit of cooperation/decision-making, may be required.

A common bias in areas where settlement is organized on the basis of discrete family groups is to treat the family group as a household and work only with the head of this group (Simelane, 1984). Other common biases are to ignore female-headed households and to treat polygamous units as single households (Sutherland, 1986). For this reason, it is not advisable to leave household definition up to extension workers or other support staff; the teams' social scientists can be consulted.

Handling Inter-household and Intra-household Linkages

Conventional approaches to selection, such as the selection by extension staff of contact farmers, tend to obscure linkages because farmer cooperators are often scattered. The community approach provides an easy way for FSR teams to access and study inter-household linkages because neighboring households are selected as part of the approach.

Understanding household linkages may be very important when FSR teams are carrying out trials that address constraints in relation to draught power shortages, labor bottlenecks and food processing and storage. Once the household has been defined, it is possible to deal with inter-household linkages. These usually vary according to the nature of the local community structure. In Zambia the linkages are often stronger in areas where settlement is characterized by dispersed homesteads or hamlets, as opposed to large villages. In areas where cattle are used for draught power, inter-household linkages are often more important in production activities (Sutherland, 1987a). In areas where cattle are absent, linkages often play a more crucial role in the organization of consumption (e.g., food sharing and communal cooking arrangements).

Intra-household linkages relate mainly to gender or husband/wife relations and also to relations between adults and children. Trials that deal with crops that are traditionally cultivated by only one sex need to be carefully planned in relation to gender differences. This is being planned as technical intervention. Relations between adults and children would be important if the trial addressed a constraint in which children's labor was important, such as bird scaring or herding (Reynolds, 1984). A common bias is to deal solely with the husband, particularly when discussing which trial to plant and where to plant it.

Matching Households to Trials

Having gone through the above steps, the FSR team can confidently select individual farmers for trials in a purposive way. The list of residential units within the target area provides an approximate picture of the size and characteristics of the population from which to select individual households. The on-farm trial program usually requires a specific number of trial sites for each trial. Making allowance for the possibility of having more than one trial on some farmers' fields and for some farmers dropping out of the program, it will be possible to come up with a specific number of farmers required. Zambian experience has been that by using a community approach where clustered trials are supervised by only one trials assistant, a larger number of trial sites can be covered than by using a conventional approach. However, the number of sites should not normally exceed 30 - 35, and the number of farmers should not exceed about 25. Such parameters allow for two to four separate on-farm trials with between 8 and 15 replicates per trial (or more trials with fewer replicates). This represents a considerable increase in on-farm research capacity in situations where team agronomists are often under great pressure to conduct more trials (especially variety trials) than they feel they have the capacity to manage using the conventional approach to farmer selection. In reality, the number of farmers required will also depend on the design of the trial, which may vary according to agronomists preferences.

Once the required number of farmers is known, the next step is to enumerate the households in the settlement groupings selected as appropriate for the on-farm trial program. This enumeration can best be done

by visiting the selected settlements, listing the households and grouping them into clusters. Clusters identified in Zambia usually range from three to six households. At the same time that households are listed, their location and the soil-type of fields should be noted on a sketch map. The main crops grown and the household's willingness to host a trial should also be recorded. This task can usually be accomplished in less than two days and gives a fairly complete picture of the final target communities selected.

Each type of trial is likely to require a different number of farmers and may also be targeted at a different cross-section of the local farming community.

For example, if the trial is a researcher-managed and -implemented problem identification trial, it may require a smaller number of larger and more literate farmers. For levels-type trials, the same type of farmer is also likely to be better due to the fact that both timeliness of operations and an appreciation of the trial objectives are important. An alternative strategy would be to include a large proportion of the smaller/ suboptimal management farmers in this type of trial and if necessary modify the trial design to fit the farmer's production system, rather than vice versa.

For verification trials, it is essential that representative farmers be used and that the trial design enable easy assessment by farmers. For this type of trial, a community approach to selection is most valuable because it can provide many farmers with adjacent fields to enable easy comparison by farmers as well as trials assistants and researchers. It is worth noting that in the Zambian experience, even when fields are adjacent, there is often considerable variation between sites in both soil type and farmer management. As rainfall is a more constant variable, differences between sites are more easy to explain than if sites are widely scattered. This is a further argument to support the clustering of trial sites as often differences between sites remain unexplained at the end of the season, and agronomic analysis concentrates on aggregating results rather than upon probing biological interactions on farms by comparing adjacent sites and trying to explain different outcomes.

The final selection of households should attempt to minimize the distance between trial sites and residences within the target community. In Zambia it is often possible to cluster sites by recruiting households living together, often related by kinship and marriage, and with fields adjacent. Such arrangements allow for the clustering of three to six trial sites in one locality. The 25 or so households may be grouped into between five and eight such clusters.

In addition to reducing logistical demands, an advantage of this type of clustering is that much can be learned about inter-household linkages. Assumptions about constraints addressed by the trial, particularly labor and draught power constraints, can be tested through observation on the spot. Moreover, much useful general information can be collected that might otherwise have gone unnoticed with the conventional approach as the FSR team is often too busy rushing from one trial site to another.

One word of caution is necessary before proceeding to the case example. Selecting trial farmers using the community approach must include technical variables as well as socio-economic ones related to equity. For example, a knowledge about the farmers' field, his or her cropping history and plans for the coming season may be essential in order to select the right farmers for the right trials. If these variables are overlooked, there is a danger of having a representative group of farmers but with quite inappropriate trials on their fields.

THE CASE OF FARMER SELECTION IN CHIPAPA, LUSAKA PROVINCE, ZAMBIA

Background

Farming systems research in Zambia is institutionalized through the Adaptive Research Planning Team (ARPT), a section within the Research Branch of the Department of Agriculture (Kean and Chibasa, 1983). Each province has a team comprised of a farming systems agronomist, an agricultural economist and a research extension liaison officer. Rural sociologists provide input on a regional basis. On-farm trials are conducted with the help of "trials assistants, " field staff seconded from the Extension Branch who stay in the target areas.

Lusaka Province ARPT started diagnostic survey work in 1980, and Chipapa was the first target area selected within Traditional Recommendation Domain 2 (TRD2). TRD2 is a domain characterized by ox cultivation of maize, subsidiary food crops and limited cash cropping. Poor access to oxen was hypothesized to cause farmers to plant their long-season hybrid maize late, resulting in low yields. On-farm research had focused mainly on addressing this problem by introducing short-season hybrid maize. A second research thrust was the introduction of late-planted crops, such as beans, soybeans, sunflower and short-duration sorghum, as alternatives to maize.

After four seasons of trials in Chipapa, it was decided to review the farmer selection procedure. One factor that prompted this decision was a transport problem; the trials assistant's motor bike had broken down the

previous season with the result that trial sites that were more than walking distance from his house had been neglected. A change of staff provided a further opportunity for reviewing the situation. There was a new trials assistant without established relationships with the previous trial farmers. The new agronomist felt that selections in previous seasons were biased towards resource-rich farmers and decided to involve the rural sociologist to select more representative farmers and also to bring about more farmer participation in the experimental program.

Previous approaches to farmer selection in Chipapa had been to hold meetings organized by the local extension staff at which trial activities were described and volunteers requested. In the first season, a few farmers close to the trials assistant's house were selected. In the second season, the trial program was expanded, a motorbike was acquired, and three sub target areas were selected, one around the trials assistant's house, one about 10 km north and the third 8 km south. In 1984 it was decided to reduce the size of the area by concentrating trials in three villages closer to the trials assistant's house. Again, selection was based on volunteers selected at meetings. While reducing the distances between sites for ARPT staff, this change did not significantly reduce the trials assistant's dependence on a motorbike as the clusters were still beyond walking distance.

Introducing a Community Approach

In order to bring the ARPT team closer to the farmers and to ease travel logistics, it was decided to select only farmers within walking distance of the trials assistant's house (up to 45 minutes). This would remove the trials assistant's dependence on a motorbike. It was also felt that traveling on foot would increase informal contact with local farmers and provide more opportunities for the observation of agronomic factors on farmers' fields through the season.

The actual selection of fanners took place within technical, agroecological and socio-economic parameters. These included the nature of the trials, soil and climatic variables and farmer characteristics such as cropping history, access to draught power and gender.

The on-farm experimental program for the season was to include three main trials: maize varieties (verification trial farmer-managed), late-planted alternative crops (verification farmer-managed) and maize/sunflower/ cowpea intercrop (exploratory trial farmer-managed). A sorghum variety trial and the testing of a new pumpkin variety were also planned.

The agronomist wanted to replace researcher-managed, small split-plot designs previously used with larger but simpler trials that left most management decisions up to the farmers. To give credible statistical results, this implied having more replications and in turn more farmers than in previous years. In fact, the number of trial farmers required was a minimum of 24. This figure assumed each trial would have a minimum of 9 sites/ replications, and that 12 of the 24 farmers would have 2 trial sites (each for a different trial), while the other 12 would have one trial site, giving a total of 36 sites.

The agronomist wanted to spread the trials over predominant soil types in the domain. This involved selecting sites on both hilly and flat areas and on both lighter gravelly soils and heavier clay soils. Rainfall was known to vary locally, but a minimum distance between clusters of sites was not established in advance of the selection; it was felt that major differences would be related to farmer management and soils rather than to climate.

Regarding target group characteristics, it was known that a large proportion of the target group did not own oxen and depended on hiring. Although figures were not available, it was also suspected that female-headed households constituted a significant proportion of the population. In addition, not all farmers regularly grew the crops planned in the trials (sorghum, sunflower, soybeans, kidney beans and sunflower).

As the target area, Chipapa, had been selected previously, not all the stages of farmer selection outlined above were necessary.

The first step was to examine the representativeness of villages. A list of 15 villages within the Chipapa agricultural camp area was compiled. The main characteristics of the villages in relation to soil type and crops grown were noted. Five of the villages were identified as within easy walking distance of the trials assistant's house. These five covered the range of soil types and included sorghum growers. A sketch map of their location was made. By interviewing extension staff and local people, the trials assistant compiled a preliminary list of households in each village. For each household, data on resource base and crops grown were recorded. The approximate walking distance (in minutes) to each household was also recorded. At this stage of collecting information, it became clear that a sufficient number of farmers could be selected from three out of the five villages. The three villages chosen included two closest to the camp that had the biggest range of soil types and

topography and the most sorghum growers. These two villages also represented one of the main arable, producing areas of the camp, a bias that reflected the on-farm trial thrust towards crops rather than livestock enterprises. The third village straddled the road that ARPT officers used to enter the target area. This selection permitted easy logistics for visiting both farmers and sites.

Verifying the list and selecting households required a more direct field involvement from the ARPT team. The rural sociologist and agronomist made an effort to visit each household in the three villages and interview the household head to verify the information recorded in the preliminary listing of households. This involvement was essential as it brought up key issues relating to household definition and inter-household linkages. During the exercise it was discovered that a considerable number of households had been left out of the list, particularly female-headed households. The reason for this was that the definition of what constituted a household had not been made clear in advance. The settlement pattern was characterized by dispersed family groups. Having conducted enquiries to establish the nature of these groups, households were subsequently defined as one or more adult persons with a separate plot, grain store and sleeping quarters. Such households tended to cluster in small groups around family heads who had an obligation to allocate arable land and provide animal draught power. Often the family head had been recorded as the household head. It should be noted that issues relating to household definition arose largely because these issues had not been considered during the informal and formal surveys conducted in the target area. As a result, the overall understanding of the farming system had been affected by inadequate attention to sociological variables.

After a full morning of visiting households, the initial list of 48 households in the two largest villages was expanded to 68, with others left unrecorded. It was decided to stop at this point as a sufficient number of potential trial farmers had been identified. This exercise illustrated the dangers of assuming that official lists are complete and the importance of verifying lists made by field assistants.

During the visits, household heads were asked if they would be willing to participate in the trial program. All readily agreed, making it clear that it is not only those who volunteer at meetings who are in fact willing to participate; when individuals are approached, nearly everyone is potentially a willing cooperator. The only reservations about participation came from a cluster of four female heads of households who explained that they didn't know how they would be plowing since their oxen had died. After assurances that they would be expected to plant the trials only when they were ready, they too agreed, and three of the four did host trials. At this stage definite arrangements were not made, but it was noted which trial might be suitable for a particular household. Farmers were told that the trials assistant would contact them later when he required their help.

The professional time required to make the above preliminary selection was a full morning. In the first part of the morning, 16 households grouped into four clusters on the basis of proximity of fields and dwellings were identified from one village. In the remainder of the morning, three more clusters totaling 18 households were identified from the second village. These three clusters were based solely on proximity of fields, as experience of the previous clusters had shown that sometimes proximity of dwellings and fields did not coincide. Some of the households in each cluster were visited and fields inspected in conjunction with a representative of the household. Sketch maps of the household's field and adjacent fields were made on the spot based on information provided by the household representative. The trials assistant was left with the task of making follow-up visits to households not visited but identified as potential cooperators on the basis field proximity and the task of making sketch maps of fields of the 16 households in the first village. No major problems were subsequently experienced by the trials assistant in obtaining the agreement of farmers.

Of the 34 potential cooperators first identified, 31 subsequently agreed to host trials. At the time that guidelines for planting the trials were being discussed with selected farmers, nine more neighboring farmers were identified, giving a preliminary total of 40 farmers. Over selection of the provisional total of 24 was done on the anticipation, based on previous experience that a proportion of farmers would drop out and also that less than half might be willing to host more than one trial.

During the selection an effort was made to keep within the parameters relating to access to draught power, gender and cropping history.

In the initial selection, approximately half of the households selected were ox owners, matching the target. Female-headed households accounted for 40%, exceeding the target of one in three. With regard to reported cropping histories and plans, the proportion growing only maize as a major crop (60%) was over-represented in relation to trial needs while the proportion growing sorghum was under-represented (12%). A significant proportion (35%) were growing sunflower and/or other cash crops, so it was felt that selection for intercropping and alternative late-planted crops trials would be feasible.

Matching farmers to particular trials was achieved through negotiation with farmers rather than by giving them an open choice. Most of the farmers selected would have preferred to have the mixed maize variety trial, but some of these were subsequently persuaded to accept other trials. In four cases, farmers agreed to one trial in addition to the mixed maize trial, and in two other cases they agreed to host both the intercropping and alternative late-planted crops trials. Finding enough farmers for the sorghum trial was more difficult, reflecting the low priority of the trial from the farmers' point of view. However, as the trial was regarded as important for strengthening links with sorghum commodity researchers, an effort was made to select extra farmers. The matching of farmers to trials prior to planting was as follows: mixed maize trial 15, sorghum trial 11, intercrop trial 10 and late alternative crop trial 10 (giving a total of 46 potential trial sites and 40 farmers).

Ongoing Experience with the Community Approach in Chipapa

Through the 1985/86 season, the community approach proved resilient, even though some farmers dropped out and others failed to plant. The trials assistant managed to make up adequate numbers without difficulty by selecting alternative farmers from adjacent fields. The number of farmers planting stood at 28, four above the original target of 24, and the number of sites planted was 32. This was more than double the number of sites and farmers compared with the previous highest year using the conventional approach to selection.

The selection of alternative farmers did not seriously bias the final sample of farmers selected. Nearly half (48%) of the farmers planting were non-oxen owners, more than a third (42%) were female-headed households, and more than half (52%) did not grow cash crops. Nevertheless, it was the resource-poor farmers who were more likely to drop out: 63% of drop-outs did not own oxen, 55% were female-headed households, and 65% were not growing cash crops. A similar pattern was repeated the following season.

In the 1986/87 season, 56% of farmers planting trials did not own oxen, while female-headed households were still more than adequately represented (44%). Again a high proportion of the farmers dropping out were non-oxen owners (70%), but in contrast to the previous season, only 30% of the farmers dropping out were female-headed households. The pattern suggested is that, while the less-advantaged farmers tend to have more difficulty in planting trials, a significant proportion of these can be relied upon. The experience in 1986/87 was that among the farmers not owning oxen, female-headed households in their second season of trials were the most reliable.

During the 1987/88 season, a very small trial program was conducted, and fewer farmers (22) were selected. Less attention was paid to directing the trials assistant during farmer selection. The representation of both female-headed households and households without oxen dropped. This drop was largely a function of the trial content, which included some crops not commonly grown by many farmers, particularly the resource poor, in Chipapa.

Farmer dropout. It is instructive to examine farmers' reasons for dropping out. The main reason farmers gave for dropping out in all seasons was access to draught power. The majority were relying on assistance from others in plowing, and often an arrangement made to plow on a particular day fell through, upsetting the arrangement made with the trials assistant who had to be present at the planting of the trial. This was especially a problem when the hired/borrowed oxen came ahead of the expected time and the area reserved for the trial was planted to the farmers' own crop. Other not entirely distinct reasons farmers gave for dropping out were shortage of plowed land, dislike for the trial and lateness in the season. These reasons were commonly given for not planting the sorghum and inter-cropping trials, probably reflecting the farmers' own crop preferences and management priorities; for planting maize rather than sorghum and intercrops; and for weeding crops already planted, rather than planting extra areas of land.

While farmers gave different reasons for dropping out, the actual pattern suggested that an important reason was lack of confidence in the trial. A lesson to be drawn, therefore, is that using a community approach in combination with an analysis of farmer dropout can provide a useful assessment of farmer reaction to new technology, the kind of assessment that is absent when farmers volunteer at meetings. A further conclusion is that using resource-poor households as trial cooperators in ox-cultivating systems may considerably reduce the researcher's control over management of the trial, especially the time of planting and quality of land preparation. If the trial is 100% farmer managed, it is unrealistic to ask the farmer to give a date when he or she will plant. After giving careful instructions to the farmers, the trials assistant can request to be informed immediately when the trial is being, or has been, planted. This will not greatly inconvenience the resource-poor farmer when a community approach is used and the trials assistant stays nearby.

Field days. Apart from improving the level of trial planning and management, the community approach made the organization of field days during the growing season much easier. Visits by commodity scientists from

the central research station were easy to organize, and many more sites were covered than previously when sites were widely scattered. Instead of formal field days for farmers as held in previous seasons, several gatherings of farmers were organized on the spot during the season. These were easy to organize, and much useful feedback was obtained without the usual formalities and constraints during an official field day. The clustering of trials made informal farmer meetings easy to organize.

System information. A further bonus of the community approach was the information it provided indirectly on other aspects of the farming system in Chipapa that were previously misunderstood or had gone unnoticed. The issue of oxen ownership is a case in point. Previously it had been assumed that planting took place whenever there was adequate soil moisture, that farmers without oxen hired from their neighbors, and that weeding was predominantly by hand. A prolonged wet spell in the 1985/86 season encouraged weed growth to the extent that ox-owning farmers were using oxen for interrow weeding in order to save their crop rather than assisting other farmers with plowing. Moreover, during the course of planting trials, it was found that very few farmers hired oxen for cash as had previously been assumed, but instead most borrowed from relatives on a rotational basis or made some kind of reciprocal arrangement with neighbors. A further assumption that ownership of oxen was the major constraint to timely planting was also questioned. In one case, a female-headed household owning oxen plowed and planted late because the oxen were first hired out to neighbors without oxen. The reason given was that the boys herding the oxen throughout the year relied on hiring out as a source of income and so gave priority to the fields of customers rather than to fields of the owner. In other cases, the practice of rotation around fields of relatives caused oxen owners to plant later than would have been the case had their own fields always had first priority. These households had been scattered and the team had not had time or opportunity to observe such interactions.

Improved accessibility and roadside bias. A further point about accessibility and roadside bias needs to be made. The community approach described above enabled a rapid selection of a relatively large cross-section of farmers in an accessible geographical area. This allowed the new trials assistant, during his first year of work, to cover his area on foot and effectively monitor all trials planted. The need for accessibility did, however, introduce an element of roadside bias. To verify the extent of roadside bias, brief visits were made to more distant areas. Findings revealed basic similarities in farming systems in most cases. However, visits to less accessible escarpment areas east of Chipapa revealed some differences in cropping patterns (more sorghum) and tillage (less use of oxen), more use of dambos and a different rainfall pattern. These differences in farming system were considered sufficiently important to consider recognizing an additional recommendation domain, or subdomain, on the escarpment. The following season (1986/87) the trials assistant had a motorbike, and some trial sites were also planted in this area. This was an interim arrangement with a view to assessing the need to establish a second sub-target area at a later time when resources permitted. Subsequent reductions in staff and breaking down of the motor-cycle have forced a temporary withdrawal from the escarpment, with trials reconsolidating in villages around the agricultural camp.

Retrospective improvements. On reflection, more time could have been spent during the initial collection of background information, particularly the location of fields in relation to dwellings and the scattering of land-holdings. More detailed information on the farmers' previous cropping histories would have been very useful, both for the intercropping and the other trials as well.

Demonstration and Dissemination

Looking ahead to the more widespread testing and dissemination of new technologies, a different approach to farmer selection may be required. After test demonstrations have proved successful in the target area, the clustering of farmers used in on-farm trials may need to be dropped in favor of an approach that covers a wider geographical area. One or two farmers from each cluster may be selected along with a good number from other parts of each recommendation domain. Farmers selected should be located near denser population areas and in the centers of these. If the T and V system of extension is operating, the contact farmers will obviously be involved. However, care should be taken to ensure that factors such as gender, wealth, age, language and local origin are representative of the target group. One option is to persuade extension staff to use some of the previous farmer cooperators as contact farmers. Interestingly, in Chipapa the extension officer responsible for demonstrations has selected some of the poorer ARPT farmer cooperators for the coming season's demonstrations.

FUTURE IMPROVEMENT

While the community approach has shown important benefits, there is still considerable scope for increasing levels of farmer participation in the on-farm research program. The approach should not simply be seen as a way of making for easier and less costly logistics for on-farm trial management. The more narrow geographical focus allows for an improved rapport between ARPT scientists and the introduction of more participatory approaches to research planning.

A final point is that using a community approach was made easier because ARPT had been operating in Chipapa area for a number of years, and so most of the local people understood what was involved with hosting on-farm trials. If a new target area were selected for such an approach, it would clearly be necessary to call one or more meetings within the community in order to explain the purpose of the on-farm research program in advance.

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Global Papers:

Gender and Intra-Household Issues in FSR/E

GENDER ANALYSIS IN FARMING SYSTEMS RESEARCH AND EXTENSION PROJECTS

Susan Virginia Poats[1]

> We all wear strong blinders when it comes to gender. It is difficult for what we actually experience to penetrate these ideological barriers …we repeat what we hear, despite what we see or do. We talk to the woman, and she declares that she does not engage in field work, just a little bit of planting, weeding, harvesting. . . . (Garrett and Espinoso, 1988).

INTRODUCTION

This paper will first examine briefly the background and current status of the interaction between farming systems research and extension (FSR/E) and gender issues. Part of this examination will be the preliminary results of a questionnaire sent to all of the lead authors of the abstracts submitted to this year's Symposium. While the complete set of responses is not yet available, the initial results indicate what might turn out to be some interesting trends in the institutionalization of gender issues in FSR/E. In addition, since most of us are usually on the delivery end of a survey, I think you will find it interesting to learn how you fared as a respondent and to compare your answers to those of your colleagues. Drawing upon the questionnaire results and other secondary information, I will then lay out some of the lessons learned thus far in the integration of gender issues and FSR/E. Based on these lessons, I would then like to propose an agenda for the future focusing on training in methodological skills, training of trainers and the staffing of field teams.

Before going any further, a note on terminology is needed. The term "sex" refers to the biological differences between males and females. The term "gender" is a social construct and refers to the learned behavioral differences between men and women. As a social construct, gender roles are flexible and variable across cultures. This paper focuses on gender issues and analysis in the process of FSR/E.

As the FSR/E approach has matured, in both its application and methodology, increasing attention has been focused on an area that is often defined as "gender issues." Like FSR/E, "gender issues" is shorthand or a "code" for an extensive field of interdisciplinary research and practice (Poats et al., 1988). The application or integration of gender issues across the broad range of FSR/E activities is not complete, nor has it been accomplished without difficulty. In some projects, consideration of gender issues is a pragmatic decision, simply a way to do better on-farm work. For others, it has been, and often still is, an emotional battle. The process of integration is not complete, but much progress has been made, and there is a great deal to learn from the experiences of those projects and institutions where gender-awareness and analysis have been achieved.

WHY CONSIDER GENDER ISSUES IN FSR/E?

It is useful to consider briefly the history of gender issues in FSR/E before reviewing the current status of gender analysis in projects. The farming systems approach to agricultural research and extension emerged in the 1970s as a response to the challenge of developing technologies that would be appropriate to the needs of low-resource farmers. This task required an understanding of farmers, particular constraints, goals and farming practices that went beyond strictly technical and economic criteria. Definition of the farming environment of low-resource producers also required FSR/E to focus on the management and decision-making abilities of farmers. This in turn led to an emphasis on the household as the central unit of the farming system. While the focus on the household as the controlling unit of the farming system was part of a long-needed recognition of the rationality of low-resource farmers, it unfortunately served to obscure the differences among individuals within the household. Practitioners, borrowing from the household models proposed by economists at the time, assumed that the household functioned as a single unit of production and consumption. It was further assumed

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[1]Anthropologist, co-manager of the Gender and Agriculture Project, Population Council and consultant to Tropical Research and Development, Inc. This paper is based upon the preliminary findings of a survey conducted ***at*** a part of a project with Tropical Research and Development, Inc. and funded by the Office of Women in Development, USAID.

that consensus among household members existed on how to allocate resources and benefits and that all household members' interests and problems were identical (Cloud, 1988).

In recent years, these beliefs and assumptions about farming households have radically shifted. It is now widely recognized that intra-household relationships are as diverse and dynamic as the relationships between households. Individuals within a household may share some interests, have separate interests and at times have opposing interests (Feldstein et al., 1987; Cloud, 1988). Technology that may help one farmer in a household may actually hurt other farmers within the same household. The recognition that these diverse and complex relationships among members of households must be considered in the design, testing and evaluation of new technology has provoked some of the most exciting and innovative methodological developments in FSR/E to date.

The shift from a unitary household assumption to an intra-household dynamics perspective in FSR/E has not occurred by accident. Rather, it is the result of convergence between two separate but related fields of research: the social science of agricultural development and women in development, or WID.

First of all, exploration of the low-resource farming environment opened the door in agricultural research and extension for the growth and development of a social science of agriculture. While there are excellent examples of social science research in agriculture prior to FSR/E, the approach changed the function of social science research applied to agriculture in several important ways:

1) FSR/E encouraged expansion of social science involvement from a narrow band of agricultural economists to a broad range of social science disciplines;
2) Rather than working in rural isolation on disciplinary studies or on a discontinuous basis conducting post-mortems on projects gone astray, FSR/E provided the medium for social scientists to become part of interdisciplinary teams and to ply their trades in the actual development of technology;
3) The development of institutional structures to contain FSR/E in research or extension institutions at last provided a "home: for the social sciences in agriculture" (Bingen and Poats, 1988).

These three changes "conditioned" the environment of agricultural development to allow for a focus on intra-household and gender issues, but it was the growing WID field that provided the tools to do the work.

The WID field, like FSR/E, began with a concern for the distribution of development benefits (Poats et al., 1988). Esther Boserup (1970) broke the ground for WID with her work that challenged the prevailing notion that economic development would automatically improve women's status by replacing traditional values and economic backwardness with new opportunities and an egalitarian ethos. She argued instead that economic innovations often replaced women's traditional economic activities with more efficient forms of production controlled by men. The recognition that development might worsen women's position relative to men's crystallized the new field of women and development around a concern with equity.

However, by the end of the 1970s, the growing WID research base showed that, in addition to equity, women's roles were intimately related to more technical problems of efficiency and productivity. Numerous studies showed that women were active producers whose potential contributions were often overlooked or undermined. A clearer understanding of women's role in production was essential for the success of agricultural development projects. Key to understanding was the development of appropriate methodologies for studying the complex dynamics of rural households. These tools were not endless checklists of questions to be asked and data to be gathered in each project setting. Rather, the new tools were actually frameworks for analysis or "conceptual maps" that proposed categories for inquiry and analysis that would help researchers and development workers identify relevant information on who does what (activities analysis), the factors underlying decision-making in the access and control of resources, benefits and incentives and the process by which women and men are included (or not included) in development activities (Feldstein et al., 1987). A significant difference in these new frameworks was the movement away from attention only to women in development and toward a focus on "gender issues."

The notion of a conceptual framework for outlining key issues of inquiry and handling differing outcomes depending on the particular setting fits nicely with the client-oriented field-level activity of the FSR/E approach. However, the convergence of these two methodological spheres occurred primarily because there were social scientists within the agricultural research and extension system doing FSR/E who were capable of taking the methods and tools of WID and applying them to the practical problems of technology development.

The shift in WID methodology from women's issues to gender issues is both significant and opportune for the integration with FSR/E. The need to disaggregated farm households in order to identify the constraints

and problems of individual farmers and to reconsolidate farmers in groups of those sharing particular research problems (recommendation domains) is recognized, but the fact that households can be disaggregated in a number of ways—by age, status, seniority or gender—can potentially complicate the methodological strategy. However, gender has proved to be the most useful household behavior (Cloud, 1988). Thus, today in FSR/E we continue to see the household at the center of the farming system, but increasingly, gender issues and gender analysis are tools of choice for opening up the household for more equitable and efficient analysis in technology development.

CURRENT STATUS OF GENDER ISSUES IN FSR/E

The extent to which gender analysis is currently used in FSR/E can be gauged by the number of conferences, workshops and networking efforts at international and regional levels and the attention the topic is receiving from donors.[2] Since 1983, at least six major international conferences and workshops have been held on gender and farming systems research.

One of the earliest international conferences on households and farming systems was organized in Bellagio by the Rockefeller Foundation in 1984 (Moock, 1986). Though some participants commented privately that the separate camps of FSR and household folks talked past each other, the papers published from the conference represented some of the earliest work in the field. The conference called for increased attention in FSR to the roles and responsibilities of women. Though some participants expressed concern about the difficulty of incorporating gender concerns into farming systems research, others such as Guyer contended that it "is not a question of grafting on a new factor, but of having recourse to a whole other framework of analysis, one which holds fewer factors constant and, as a result, can address long-term change" (Moock, 1986).

Though some of these conferences, like the one at Bellagio, have been small, others have been quite large and diversified. At the University of Florida's conference on Gender Issues in Farming Systems Research and Extension in February 1986, over 100 papers were submitted for inclusion, 91 presenters were on the program, and nearly 300 peopled registered from more than 20 countries and four international agricultural research centers. A special ad hoc session following the conference on methodologies was attended by over 50 people, indicating strong interest in this issue.

A number of international agricultural research centers have undertaken initiatives to study and/or incorporate gender issues within their various programs of on-farm research. For example, a major network on Women in Rice Farming Systems (WIRFS) has been created in Asia with support from IRRI and IDRC. Through the actions of the WIRFS, collaboration has been enhanced between the national programs in the network and IRRI. IRRI's efforts in the arena began in 1983 with their first women in rice farming systems meeting. As a result of this, a network was created and funding secured from both external and internal sources. The network's most recent international conference, "A Training and Planning Workshop for Women in Rice Farming Systems," was held at IRRI in May. In the workshop, efforts to consider the needs of rural women when designing rice farming systems projects were reviewed, strategies and methodologies for integrating women's concerns were discussed, and technologies relevant to women were examined. A training module using case studies was conducted during the workshop in order to assist participants in conducting their own training activities in their home institutions. Rather than being limited to an exchange of information and experiences, the network meetings play a crucial role in research planning. In the recent meeting, participants developed plans for on-farm research projects as part of the network, and four more activities for the network were planned for 1988-89.

While each of the other IARCs have pursued different routes to incorporate WID issues and gender within their programs, most have done so via their various on-farm research thrusts. For example, when CIMMYT commissioned a study on work that is directed to assisting women in the developing world and its assessment at the request of several of its donors (Carney, 1988), it showed that a majority of CIMMYTs efforts that have included women have occurred in their on-farm research programs. Efforts are concentrated in the outreach

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[2] According to a paper prepared by Eva Rathgeber (1987), Women in Development Coordinator for IDRC, Canada, the following donor organizations and foreign aid divisions of countries have WID policies or programs that affect the consideration of WID and gender issues in the projects or other activities they support: UNDP, UNIFEM, CIDA-Canada, USAID, Ford Foundation, World Bank, SIDA- Sweden, SAREC, Netherlands assistance programs, DANIDA-Denmark, FINNIDA-Finland, Belgium Government and the ADAB- Australia. In addition, a set of guidelines for the integration of women into development was issued by the DAC/OECD and several countries have adopted these. She states that IDRC-Canada does not have a specific policy or strategy on the integration of women, but IDRC has given a considerable degree of informal support to research looking at the special problems of women and to the participation of women as researchers, consultants and grant recipients.

program, especially in Africa, though CIMMYT's first study exclusively on women maize producers will take place in Mexico beginning this year.

An example of CIMMYT's outreach efforts to include gender and household issues is the regional networkshop on household issues and farming systems research, held in Lusaka, Zambia, April 27-30, 1987 (Sutherland, 1987). The overriding concern of the workshop participants was how to move beyond a sensitization to the issues to inclusion of gender analysis in research activities. Participants discussed alternative methods of gender analysis and the situations in which they work best. New terms to describe field tools pushed for "overcoming the tyranny of randomization" as they looked at purposive sampling procedures. While the networkshop was a very useful activity and participants expressed a desire for further interaction on the topic, there was no mechanism to sustain the momentum.

The Secretariat of the Consultative Group for International Agricultural Research organized a seminar on "Differential Users of Technology" that was held during one morning of the last Center's Week, October 1987. The term "differential users" can be viewed perhaps as an euphemism for discussing gender and other "disaggregators" of human populations. Most of the presentations focused on women as users of technology, gender differences in technology constraints and adoption and the inclusion of women in the research and extension process, both as technology users and as technology developers. The session was held at the request of a donor to the CGIAR (CIDA-Canada) with support of several other donors and was organized by Michael Collinson. Discussion pointed to the leadership that the IARCs can offer in integrating gender and women's issues into agricultural research and development.

The CGIAR seminar during Center's Week is significant because the meeting brings together all of the major donors of international agricultural research and development to discuss and determine the kind and level of support to be given to the international agricultural research centers (IARCs) and other regional research institutes. Most of these donors either have adopted WID policies to encourage their recipients to include women in the development process or are in the process of developing policies for WID. To the extent these same donors also support FSR/E, there is considerable push today to adopt gender-sensitive development approaches and to incorporate gender analysis in agricultural research and extension.

One event not yet discussed in the preceding review is the annual FSR/E Symposium. Although this is the first symposium with an explicit focus on gender issues, the symposium has been a key forum for the exchange and development of gender analysis in FSR/E. Each year there has been an effort during the meetings to organize sessions (often under the category of "special topics") dealing with the results and methods of gender analysis and to create opportunities within the symposium to exchange experiences from the field. This has generated a large constituency for gender issues within the network supporting the symposium and ultimately in the selection of gender as a sub-theme for this year.

When asked to give this keynote address, I felt it was important to provide an overview of the status of gender analysis and was reminded of Bob Herdt's [Rockefeller Foundation] address last year at the symposium. As part of his presentation, he conducted a content analysis of the abstracts submitted to the symposium as a way of determining the current status of FSR/E methodology. It was initially suggested that something similar to Herdt's analysis could be done in order to gauge the status of gender issues among the projects and practitioners at the symposium. However, abstracts alone do not provide an adequate representation of a project, and, therefore, content analysis will pick only up those projects that are discussed in papers on the particular theme in question. Often projects have multiple activities and agendas, not all of which can or should be presented in a professional meeting.

So, after briefly considering this suggestion, I decided instead to conduct a rapid survey among the lead authors of abstracts submitted to the symposium on the extent to which gender issues are included in FSR/E projects. With support from the Women in Development Office of USAID and Tropical Research and Development, Inc. in Gainesville, Florida, and in collaboration with Sandra Russo and Jean Gearing from the University of Florida, a short questionnaire was designed and then sent to the lead author of every abstract submitted for consideration by the organizers of the Symposium. Though some of the abstracts were later rejected for presentation by the various symposium committees, we used the larger group of names in order to have the widest possible set of responses.

The four-page questionnaire included mostly short-answer questions covering the following areas:

1. Gender analysis conducted in the project (was it done, when, by whom, at what stage in project if not done initially, methods used, evaluation of impact on FSR/E stages/functions).
2. Source of the initiative to include gender issues (team member, donor, national government, target group member).

3. Training in gender issues received by project team (if so, who provided, who participated, when, what did training cover, how useful was it).
4. Disaggregation by gender of the socioeconomic data collected by the project (yes or no).
5. The extent of women's inclusion in the project (surveys, on-farm trials, evaluation activities).
6. Identification (name, discipline, gender) of the person(s) responsible for incorporation of gender into the project.

In addition to the short-answer questions, we included open-ended questions at the end of the survey on two topics: 1) obstacles to the inclusion of gender issues in projects and the strategies used to overcome them and 2) the benefits (anticipated or not) that have resulted for tie project from an awareness of gender issues and the active participation of women.

A total of 214 questionnaires were mailed out in the third week in August with a cover letter explaining that those responses received by the middle of September would be incorporated into this presentation. Any questionnaires arriving after that date will be incorporated in the final report that will be published and distributed by the Women in Development Office, USAID.

As of October 1, 1988, 46 people (21%) had mailed back a response to the questionnaire. Of these, 35 actually filled out the questionnaire. Many of the 11 who did respond but did not fill out the questionnaire explained why. For some, the work they are doing is not tied to a project, and the questionnaire was inappropriate. Four stated that gender was not a relevant issue in their work. One of these who is conducting research on cereal crops in the West African Semi-Arid Tropics said that he "does not consider gender issues in the least bit." This raises a bit of concern for the results of the research given women's roles in production for many cereal crops in that region. Most of the 11 felt, however, that the issue is important.

A communications expert commented that the "methodological problems in dealing with such issues on a short-term contract basis in a male-dominated social system are probably worth a whole symposium, not to mention related obstacles presented by the typical short-term project approach to development."

An irrigation specialist noted that while FSR/E and on-farm water management share much of the same methodology and philosophy, the latter is still firmly grounded in the physical sciences and particularly engineering and is "still very much male gender bound."

> It is a man's world. Farm families, women, children are rarely if ever referents in this program, let alone intra-household matters...there is yet a long way to go before the subject of on-farm water management will trickle down to any real concerns for gender or intra-household issues.

As a final example from those unable to complete the questionnaire, a letter came from an extension specialist working with a survey of 140 programs in the Cooperative Extension System of the United States that are using an integrated systems approach to improve profitability and competitiveness of US agriculture. She found only limited integration of the household as a component of the farm/ranch system and very few social scientists other than agricultural economists.

> None has purposefully included gender issues either in diagnosis or implementation. Household issues and family economics are generally left to the home economics staff while the agricultural staff do the farm/business production and financial management work. Change is coming though. The next 4-year program cycle is expected to bring integration across program areas and attention to gender issues in program development.

Though the 35 questionnaires received to date represent only a small sample of the total population, the results appear to indicate some interesting trends. In particular, responses to the open-ended questions provide some very revealing insights concerning the status of gender issues and analysis. It should be noted that the survey is keyed to formal on-going projects and that a number of the presentations at the symposium are based on work that is related to FSR/E but not from actual FSR/E projects.

The majority of the responses were received from Asia (15) and Africa (8). There were two with a worldwide project mandate, five from Latin America, four from the United States and one from Europe. Table 1 shows the regional responses broken down according to those projects that did or did not include gender issues.

All of the African respondents had included gender analysis at some point in their projects as well as most of the Latin American and Asian respondents. None of the US projects included gender analysis, though one did include some women as cooperators in on-farm trials. While the numbers are very small, the lack of inclusion of gender in US-based on-farm research seems to point to an area of possible resistance to the inclusion of gender as a variable in FSR/E.

Of the 35 responses, only 10 gave explicit project objectives dealing with gender, household or women. Thus, 18 of the projects that did include gender issues did so even though it was not explicit in their project objectives. On the other hand, though 28 of the projects reported that they included gender issues and analysis, only 16 of these reported that their socioeconomic data are disaggregated by gender. If the data are not disaggregated, it is difficult to see how the projects are able to measure differential use or impact of the technology or analyze gender differences in research results. Often the inclusion of gender issues, or WID issues, is interpreted only as the inclusion of women as cooperators in on-farm trials or in dissemination of results but not as an analytical variable in the actual on-farm research.

Some respondents stated that even when people knew that women were important in agricultural production, little is done about it. One researcher from Nigeria noted that,

> . . . the role of women workers is really a paradox. While it is recognized that over 70% of the farm work is done by women, they are yet to be effectively incorporated in research activities. My own concern has, however, been about farm tools which are grossly inappropriate for women on energy level and on [the basis of] anthropometric considerations.

A wide range of methods are used by these projects to either conduct gender analysis or to include women in the process of on-farm research. By far the most popular method is surveys, both informal and formal. Some projects use case studies (4) while others reported growing use of group discussions. While these findings are only tentative, it does seem that those projects deeply committed to gender analysis are moving away from the "tyranny of randomization" and focusing on more purposive diagnostic and on-farm research techniques.

The projects reported very wide ranges in terms of the inclusion of women in socioeconomic surveys, on-farm trials and evaluation activities (0-100%). However, it was clear that more women are included in the surveys than in on-farm trials, and fewer women, if any, are involved in evaluation of on-farm research.

Did it make a difference to include gender? All of the respondents who did so said yes. The actual differences varied considerably, but the most common response was that a gender focus--or use of a "gender lens"-helped the project team identify whom to work with, who was the target population for the research, and who controlled technology in order to allocate research resources appropriately. The gender focus also

- created sensitivity to women's contribution to production;
- caused methodological adjustments to include women in the process;
- changed the participation in group meetings from all men to men, women and children;
- changed some of the on-farm research sites to fields owned by female-headed households;
- added new research areas, such as a focus on home gardens;
- raised subtle issues of access and control of resources as a key variable in technology adoption or rejection.

While again I must emphasize the small size of the sample, I would like to pursue some of the possible reasons why gender analysis is included in some projects and not in others. Conventional wisdom has often held that gender-sensitive research is directly related to the presence of social scientists or women on research teams. Table 2 shows the numbers of social scientists on teams reported thus far in the survey.

The majority of the projects with social scientists on the teams did conduct gender analysis. In those that did not, the social scientists were men. Of those without social scientists, two of the three teams that did conduct gender analysis had women on the teams.

If we now look at whether having women on the teams made a difference, we find that three of the project teams were all women, 12 were all male teams, and the rest (16) had mixed teams. Four of the respondents did not identify the gender of the team members.

The total number of women on all teams broke down evenly with 20 social scientists and 19 agricultural scientists. However, the total number of men involved in the projects was over 150. Table 3 compares the inclusion of gender analysis in the project with women on the project teams to that of teams without women.

It does appear that having a woman on the team enhances the likelihood of gender analysis. However, when the only women on a team were biological scientists, often women farmers were included, but data collection was not disaggregated; therefore, analysis of differential results by gender was not done.

Who was responsible for introducing or promoting gender analysis? While we often think that the gender focus is mandated by external forces, in these projects the person who most frequently was the source of the initiative on gender was a team member (17). Funding agencies were the next most frequent sources (7). We can speculate that developing a gender focus comes only through long-term efforts of a team member in constant contact with his or her colleagues. We can also see the effectiveness of donor insistence.

One of the most intriguing results thus far from the survey comes from looking at training in WID, gender issues and/or analysis (Table 4). All of those who received training included gender issues and/or analysis in their work. The six projects where no gender analysis was conducted were all-male teams with no social scientists and no training in gender issues. What can be discerned from this preliminary analysis is that while having social scientists and women on field teams may increase the possibility that gender issues and analysis will be included, neither automatically provides a guarantee. Training, on the other hand, does appear to positively affect the inclusion of gender issues and/or analysis. Further probing on this subject may reveal that training serves to illuminate and legitimize the issue, which is then pursued most frequently by social scientists and/or women on the teams.

BENEFITS OF GENDER ANALYSIS

It is too early with the present survey to be conclusive about the benefits of including gender issues and/or analysis in FSR/E activities. However, it is illuminating to consider some of the various responses from respondents concerning the benefits they had experienced. These are listed according to the countries of origin.

Bangladesh:

> Scientists now better understand the infra-household dynamics of farming systems and the role of women in farming systems. They are able to decide who should be the participants, men or women, in the technology testing and evaluation. More experiments are now being planned for homestead areas where women are the target beneficiaries.

Nigeria:

> Appreciation of gender issue is important when developing farm tools for women.

Niger:

> The involvement of women is anticipated to result in better transfer of technology and better acceptance of the technical team.

Peru:

> There was a clear orientation toward animal production improvement through the direct participation of real producers—women. The research provided an opportunity for women to organize around a concrete and felt problem—animal improvement.

India:

> In the future, we will train women also in agricultural development work. The study revealed that women do and govern a lot of farm work which is not recognized. Everything goes in the name of men . . . . Women were better trial cooperators ...incorporation of gender resulted in smooth functioning of project with very quick positive results with little extra effort.

And finally, from an Integrated Pest Management Project in the Philippines:

The possibility of making the farmer use the correct amount and timing of appropriate pesticide through the wife is one of our objectives. Since by local tradition women (wife) act as the family treasurer, giving her a good technical basis for her pesticide purchases will change the crop protection approaches of her farmer husband.

LESSONS LEARNED

From the preliminary analysis of the initial set of responses to the survey and from the general review of the status of gender issues and analysis in FSR/E, we can begin to distill a series of lessons learned. These are not intended to be conclusive but rather to serve as a mechanism for drawing together the experiences gained thus far in order to determine the directions needed for the future. Six lessons are presented here.

1. There has been a general misunderstanding of the term "gender analysis." Many have thought it refers only to equity issues. However, gender analysis in on-farm research refers to the determination of who does what, why, and with what resources in order to improve, as Michael Collinson said in his opening keynote address, "the choice, design, and evaluation of experiments."
2. Gender analysis helps the research process by defining the right client(s) for the intervention. It has the potential and power to make the process more *efficient.*
3. Gender is the most effective tool to open up the farm household and to begin to understand its behavior. Disaggregation of information by data must be done in order to define the systems that proscribe choices. Disaggregation does not stop with gender—it must go further to include age, class, caste, race, ethnicity—but the most effective tool to start with is gender.
4. The gender analysis or conceptual framework is a useful and learnable tool for FSR/E. The key questions of gender analysis are:
   a. Who does what? When? Where? Why? (the activities analysis question.)
   b. Who has access and control of the resources for production?
   c. Who has access and control of the benefits of production?
   d. Who is included in the process of on-farm research and who might be penalized?

   These questions are not restricted to the diagnosis phase in FSR/E but are essential to the design of on-farm research and the implementation of on-farm experiments, and they are crucial to the evaluation and dissemination of the results of on-farm research.
5. Training works. When practitioners are trained in methods of gender analysis, they apply these methods to their work. Immediate problems facing us with regard to training are the identification of qualified trainers and the development of relevant training materials. A focus on and investment in training will be necessary to insure that gender analysis becomes a normal, pragmatic part of good agricultural research.
6. There is a need for a greater focus on gender issues and analysis among US-based practitioners of FSR/E. Gender is as valid an issue for US agriculture as it is for other regions of the world.

As a final thought in the consideration of lessons learned, we often ask ourselves, why is the gender issue so difficult to deal with? Several researchers studying gender relations in the Caribbean region hypothesize that when researchers examine gender analytically as an object of study, they are forced to simultaneously look inward at themselves and their own gender instability. As human beings, we tend to regard gender as a natural and fixed construct, immutable, something we grew up with. But as scientists, we are forced to question gender as a social construct, something that is not fixed but is as subject to change as any other social category. How can gender be fixed or static in one instance and fluid in the other? The simple answer is that it cannot. Gender is a changeable and changing social structure, and gender issues cut across our professional and home environments. When the client orientation of the FSR/E approach opens the scientific eye to the gender implications of technological change, and particularly to the need to include women in the process of research and extension, that same eye turns to the workplace and wonders why women are not equally included as the researchers and extension agents of that process.

While most attention to date has been placed upon the participants or clients of development and FSR/E has focused on gaining the participation of women farmers, more recently attention is being re-focused on the gender of the research and development workers. It is becoming recognized that if women are to become part of the target of agricultural development, women will also have to become part of the technical community. Though simplistic in its argument, if half of the potential human resource is ignored in the staffing of agricultural research organizations, the outcome cannot be very efficient.

AN AGENDA FOR THE FUTURE

In conclusion, I would like to present an agenda for action in the future highlighting three areas.

Methods

It is essential that we improve the methodological tools necessary to collect appropriate data and conduct gender analysis. This may imply using existing methodologies just as they are, retooling methods or developing new methods. Work in this area is well underway, largely as a result of the leadership of Hilary Feldstein and Janice Jiggins. But we must constantly push our colleagues working in FSR/E to share their methodological processes and the problems and achievements experienced in the field. We must also encourage the use of new methods without allowing them to become additional burdens—but rather tools of efficiency.

Training

The staff of national programs must be trained in gender issues and analysis. The focus has often been only on participant training in degree programs or on short courses delivered by external experts. This focus must shift to training trainers within the local systems if the methods are to become truly part of the normal process and functional at field level.

Staffing

Women do need to be involved in FSR/E as professionals. We have begun to recognize that if we want to successfully integrate women and men into the process of on-farm research, we must mirror this integration on the teams that conduct on-farm research. If we use the participation in the annual FSR/E symposium as a measure of the change in staffing of FSR/E efforts, then we have reason to be encouraged. At the first symposium, there was only one woman on the program, and women participants represented less than 13% of the total Today, eight years later, looking over the program and the gender composition of the participants, we can see that this has greatly changed and progress is being made. Let us hope it continues.

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Table 1. Number of projects by region that included gender issues.

Region	Gender Issues and/or Analysis	
	YES	NO
USA	-	4
Latin America	4	1
Asia	13	2
Africa	8	-
Europe	1	-
Worldwide	2	-
TOTAL	28	7

Table 2. Number of social scientists on project teams disaggregated by inclusion of gender analysis.

Social scientists on the team	Gender Issues and/or Analysis	
	YES	NO
Yes	22	3[1]
No	3[2]	2
TOTAL	25	5

(5 respondents were not applicable)
[1] All were male-only project teams
[2] Two of 3 teams had female members

Table 3. Presence or absence of women on teams disaggregated by inclusion of gender analysis.

Women on Team	Gender Issues and/or Analysis	
	YES	NO
Yes	18	1
No	8	4
TOTAL	26	5

(4 responses not included)

Table 4. Training conducted on gender issues/analysis and the inclusion of gender issues and gender analysis in project activities.

Women on Team	Gender issues and/or Analysis	
	YES	NO
Yes	14	0
No	10	6
TOTAL	24	6

(5 responses not included)

UNDERSTANDING WOMEN'S ROLE IN AGRICULTURE THEIR POSITION IN *PULAAR* SOCIETY (LAND ACCESS ISSUES)

by Tidiane Ngaido

Assisted by Mark Lynham[1]

INTRODUCTION

Pulaar women play an important role in agricultural production along the Senegal river valley. Women participate in all phases of agricultural activities, either with their husbands or by themselves. Under the traditional system, the role of women was perceived as secondary as they depended on their husbands or brothers for their welfare. They do not participate in the decision-making process within the society. They also face economic discrimination. Although women participate in all the household and farm activities, they are just considered available labor for the household. They receive little from their work and rarely have access to the means of production, primarily land.

This situation leads many rural developers and researchers to wonder what role women will play in the development process of the Senegal river basin. This is of great importance because in addressing the issue of women in development, researchers and project designers have fallen inadvertently into the same trap of discriminating against women in their access to land as that of the traditional system without the mechanisms that the traditional system gave women. The introduction of village vegetable gardens and the development of irrigated agriculture increased the burden for women rather than improving their condition. It induced the loss of small privileges, such as securing welfare for their children, which they had under the traditional system. The irrigation projects and the village vegetable gardens through new land allocation systems helped to confirm male domination and at the same time curbed the rights women had under the traditional system. With regard to women and development, this paper addresses one of the major issues, which of women's access to land within three broad cropping systems: (1) the traditional system, (2) the irrigation perimeters and (3) the village vegetable gardens. Finally the paper will discuss how these systems fit in the overall development process of the river valley.

The paper is based on data that I collected in various studies conducted in Mauritania. The Boghe and Foum-Gleita data were part of the Land Tenure Center project in Mauritania financed by the U.S. Agency for International Development. The data on the Dirol plain were part of the Project Identification Document (PID) and Project Paper of the Development Alternatives Inc. (DAI) in Mauritania financed by the U.S. Agency for International Development.

The *Pulaar* are found in both Senegal and Mauritania along the Senegal River basin. They have a long history of agricultural production both on rainfed agriculture and recession agriculture. They created a complex system of land tenure given that the major constraint was water. The system was flexible and adapted to the environment as the mechanisms set up were able to control land and labor and thus ensure production for any given year.

DEFINITION OF WOMEN

There is a general tendency among developers and researchers to consider women as a homogeneous group. This lack of understanding of the status of women in one society and the role they play in the agricultural sector in many cases leads to inadequacies in the strategies that are to be implemented for the benefit of women. There is a need to differentiate women according to their social status because it is this that determines the role a woman plays and the amount of time and labor devoted to agricultural production and also determines her relationship to the land she cultivates.

Among the *Pulaar* we can differentiate four categories of women: (1) married women, (2) divorced women, (3) widowed women and (4) single unmarried women.

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Married women are not generally economically independent in *Pulaar* society. They constitute labor that is available to the family both for household work and field work. They rarely receive their share of land on their family holdings unless their husband is landless or landshort. In such cases, they can ask for their share of land and are subject to the payment of a type of land tax which amounts to one tenth of the production *(Assakal).* Yet women play an important role on the production side because they share the work with their husbands and in the absence of their husbands due to migration or sickness carry out all household and agricultural activities to sustain their families.

There are two types of divorced women: (a) independent divorced women, and (b) dependent divorced women.

Independent divorced women have their own means of support for their families. All their time is devoted to agricultural production or to some other income-generating activities. Even if they live in their parents' compound, they are able to make their own decision, cultivate their own or leased land. They work their plots or fields from land preparation through storing their product. The women are helped on their fields only by their children and sometimes their brothers or cousins. The majority of these divorced independent women are old, and as their families cannot support them and their children, they tend to be independent. However, as married women who received their share of land, they are also subject to the payment of one tenth of their production to the male leader of the family.

Dependent divorced women are supported by their parents, brothers or uncles. They are generally young and do not have a large family. In such cases, they share all the labor tasks within the family. Because they are supported, they cannot ask for their share of land in the family holding. However, the person in charge of the family land can always grant them a small piece of land, *lowre***,** to cultivate.

Widowed women are generally independent in *Pulaar* society and have their own means of production and their own houses. They support their families by working the land. In many cases, if these women do not hold land, they rent land or work as laborers on other people's land, receiving part of the production as compensation. In some cases when the widow receives remittances, she can hire someone to cultivate her field or she can lease out her fields. If she remarries, *bar***,** she still retains her economic independence and continues to make her own decisions. If the widow is young, the brother of her deceased husband can remarry her so that the children will stay with their mother in the same family. This is also another way of avoiding land fragmentation within the family.

Unmarried single women are in the same category as divorced dependent women because they are supported by their families and participate in all household and agricultural activities.

The independence of women in the *Pulaar* society is a new phenomenon due to the changes in the social structure and economic activities. The extended family compound is being broken up into small, independent units that make the extended family unable to secure the welfare of women and their children. Moreover, due to the introduction of irrigated perimeters where land allocation is on an individual basis, the family does not have the means to support all its different members.

WOMEN AND THEIR ACCESS TO LAND UNDER THE TRADITIONAL SYSTEM

In many *Pulaar* areas, women in general rarely have access to land. However, differentiation ought to be made between different regions of the Senegal river basin. Depending on the evolution of the society and the land available to the people, the *Pulaar* created ways to manage land and labor. Even when the land is divided, it stays in the hands of the male members of the family. Women who have received their share of family land are still subject to the payment of a tithe amounting to one tenth of the production. This is given to the oldest male person of the family, which suggests that women have only a secondary ownership in their share of land. This discrimination against women holding primary ownership rights was meant to preserve the wealth (land) of the family within the family. Because women can marry outside the extended family, giving a woman a piece of land only increases the amount of land available to the family of her husband. In the case in which a woman receives her share of family land and dies, and if her only son dies, the land that she acquired goes to her son's half brothers. So in *Pulaar* society, in order to preserve the family's overall wealth, certain mechanisms have been created so that when a woman is widowed or divorced, it is generally her brothers who take care of her and/or her children. But if the family fails to give the widowed or divorced woman this security, she can ask for and should receive her share of the family land.

This system of inheritance and the necessity to preserve the preeminence of the extended family unit within the *Pulaar* society in avoiding land fragmentation may be one of the reasons why many marriages are among

extended family members. Cousins marry cousins in order to preserve the land within the extended family.

However, if a woman does not claim or take her share of family land, her brothers are obliged to give her a part of their harvest *(caatal)* each year. This maintains good family relations and at the same time allows her brothers to cultivate the land. If the brothers who cultivate her lands fail to give her the *caatal* after the agricultural season, she can always claim her part of the land, which she can cultivate herself or rent out. Such cases are rare because, when it does happen, it generally causes splits within the extended family. Nevertheless, the traditional system requires that the woman pay *Assakal* to her brothers or uncles. This payment assures her land ownership rights within the family.

It is important to make clear that a woman can receive her field whenever she wants it and her children can also claim their mother's share. It is for this reason that some farmers will claim that they inherited their fields from their mothers *(yumam-ndewmi).*

In other cases, a woman can hold in trust for her children the land of her deceased husband. This is why many widows are able to cultivate land. A divorced woman who cultivates generally does so on land of her own family and not on her husband's land unless, as mentioned above, the husband dies and the woman or the children reclaim their share of their father's family land. Thus, under the traditional system, when divorced or widowed women cultivate their husband's land, they do so only on behalf of their children. They claim or retain ownership rights for their children in order to ensure their children's welfare. However, the divorced woman receives land from her husband's family only if she is in charge of the education of the children. When the former husband is in charge of the education of the children, she loses access to those lands.

The reason why the traditional system tried to reduce women's access to land is an economic one. Women receive half of a man's share under Islamic Law, and the existence of many share holders makes any land division on those small plots difficult. To avoid further land fragmentation into non-economical plots, the different share holders use their fields in a one-year rotation system. For example, in the Dirol Plain in 1987, three farmers cultivated their receded fields by using a one-year rotation system. This adaptation is meant to assure equity between the different share holders.

In general, under the traditional system, women are able to obtain access to cultivable land if their families are landowners. The difference between men and women in access to land is the fact that when a woman obtains cultivable land, she is subjected to the payment of the *Assakal* to her brothers or uncles, whereas men who cultivate land are subjected to the payment of the *Assakal* only if the land is commonly held and then the payment is made to the oldest male person of the family. Nevertheless, the payment of the *Assakal* permits women to secure their ownership rights because all the land disputes are settled by the male members of her family. Furthermore, the traditional system ensures that the woman's children are allocated land whenever the children need it. It also permits them to maximize their welfare because they can have access to larger fields when the land is not claimed by their mother. Indeed, if their mother did not claim their share of land, then all the children may have access to land that does not belong to their mother but that they can cultivate. However, when the woman asks for her share, which is generally small, it may be that all the children will be able to cultivate at the same time in that field as mentioned above, since they use a one-year rotational system.

WOMEN AND RAINFED AGRICULTURE *(JERI)*

Women's involvement in rainfed agriculture is very important. This may be explained by the ease with which women have access to this type of land and the adverse situation of those women who do not get access to flood recessional lands to generate enough grain to see them through the whole year. In the Dirol plain, during the 1987 rainfed agricultural season, 306 female heads of households cultivated individual fields of *jeri.* This represents 16% of the total households who cultivated the *jeri.* However, to better understand women's involvement in rainfed agriculture, they should be differentiated by types or categories. The participation in agricultural production by the different categories of women in agricultural production during the rainy season of 1987 is shown in Table 1.

Table 1 shows that the majority of the women involved in agriculture are widows (43%) and women whose husbands have migrated (40%), which shows the important role that women play in the support of rural families.

The *bar***,** remarried widows, represent only 9% of the women involved in the *jeri***.** In this case the women are obliged to be self sufficient as the remarriage is generally a symbolic affair. Thus if the widow does not have children to take care of her by providing food and shelter, the *bar* is then obliged to work for her survival.

Two villages, Fondou and Dawalel, were found to have higher percentages of women cultivating land on their own (20% and 13%, respectively). This is due to out migration by husbands and a higher number of widows. The high number of women whose husbands migrated confirms the hypothesis that women play an increasingly important role in agricultural production. On the other hand, widowed women tend to be more independent and ask for their share of land, which results in their high participation.

The involvement of women in rainfed agriculture in the 1987/88 crop year was very important, especially with regard to widows and those women whose husbands had migrated. The data suggest that there are changes in the structure of the *Pulaar* families due to the drought because men are obliged to migrate, and women have taken over the agricultural activities that the men used to carry out. What will be the implications of such changes? Will women continue to cultivate individual fields to generate income once their husbands are back? Or will they revert to being considered labor available to the family? The data seem to favor the latter possibility since we did not record any married women living with their husbands who cultivated their own fields.

WOMEN AND RECESSIONAL AGRICULTURE *(WALO)*[2]

The issue of women's involvement in recessional agriculture raises three important issues (1) the relation between women and their status on the lands they cultivate, (2) women and castes and (3) women and tenure arrangements. In the *walo* of 1987, 40 women (8% of the total heads of households) participated in agricultural production in the Dirol Plain.

The relationship of women with the land they cultivate is important because it reveals the importance of women's involvement in agricultural production. It also shows which women have access to land. During the *walo* season of 1987, 80% of the women owned the fields that they either cultivated or rented out while only 20% of the women leased land. Does this mean that the majority of women involved in the *walo* are landowners, or does it just mean that, since it was a low flood year, access to land by landless women was more difficult? In any case, the figures show that women are able to have access to fields to develop. It also confirms the hypothesis that independent women tend to take their own share of land because all 40 of the women involved in the *walo* were heads of households.

The relationship between women, castes and owning land is an important aspect of recessional agriculture. The difficulties in having access to *walo* fields may suggest that low caste women are less likely to own *walo* land (Table 2). In the Dirol plain during the 1987 *walo* season, the majority of the women who owned land were from the noble *torobe* caste (62.5% of the women heads of households). The data confirm, as expected, that for women of slave origin *(maccube)***,** the only two who cultivated were lessees. The major reason for them not owning land in the flooded area may be that the area owned by this caste is small and, even if their families hold land, the lands are located on the edge of the flood plains that are rarely flooded. As a consequence, cultivable land for the family members of this case is scarce, and these women do not generally have access to the *walo* fields because normally the land stays under common ownership and is controlled by the male members of these families. The *maccube* women have access to the commonly owned field only if a system of one year rotation is initiated by the different shareholders.

Table 2 shows that among the artisan women, only the women weavers *(Mabube)* were involved in agricultural production. This is the result of their ownership rights on the *Walo* lands. As the male members of their caste are landowners, women can have access to cultivable land through inheritance from their family or can retain the use of their deceased husbands' lands on behalf of their children.

The predominance of the *Torobe* women as landowners is reflective of the *Torobe* possessing more land and the fact that these women demand their share. Among the total of 40 women studied, 24 are from the lineage of the Hebbiyabe, with whom the division of land is more commonly practiced and the women have access to fields of their own. In contrast, since the Bosseabe discriminate against women because of land shortage, only 8 women from this lineage cultivate their own fields.

The importance of the relationship among women, caste and land ownership resides in the status of women, as in 1987 when all the women involved were independent. In general, a married woman whose husband is a landowner does not need land from her family. However, if her husband lacks land, she can ask her brothers for a field to cultivate or ask for her share of the family land, and, in either situation, she gives to her brothers' or her father's family the *Assakal* from her production that entitles her to her brothers' protection and assistance

[2] Thc survey was conducted in **a** very low flood level in the Dirol plain. Thus the data do not reflect the situation during a high flood year.

in case of land disputes. This is similar to shareholders of common fields giving the *Assakal* to the older member of the family for the services rendered in securing land ownership rights.

Women and tenure arrangements is a twofold issue. Since access to receded fields is difficult and particularly discriminates against women, one issue is that of independent, landless women renting to sustain their families and what type of contract they would make to cultivate land. The other issue is whether women who receive land cultivate it themselves or rent it out and, in the latter case, what the prevailing forms of land tenure arrangements are that they could make to get their lands cultivated. Table 3 shows that 78% of the landowning women cultivated their fields and that 22% of the landowning women leased their fields either under the form of temporary gifts *(dokal)* or a fifty-fifty sharecropping contract *(rem-peccen).* Twenty percent of the women who cultivated this year rented their fields under two types of tenure arrangement. Four (10%) received their fields as *dokai***,** and the other four contracted land under the *rem-peccen* contract. Three of the women who sharecropped land are from the artisan and slave castes. This shows that access to land for low caste women is difficult since their extended families own little or no land and they are obliged to sharecrop. They may be able to have access to land as a gift for one year from a *Torodo* family. But in the case of land shortage due to low floods, the *Torobe* women have greater potential access to fields for cultivation because of their social relations.

The 22% landowning women who rented out their fields are usually old widows who are able to cultivate their fields themselves. The other widows and divorced women are obliged to cultivate their fields because they demanded freedom from their brother by taking their share of the family fields. The women who rent fields to cultivate so they can feed their families are usually from poor families whose fathers cannot support them.

The situation of women in recessional agriculture shows that in the changing societies where the social structures are breaking down and the women are not finding security in the extended family, women are obliged to make their own decisions and depend upon themselves for survival. Women are becoming more conscious of the land issue, especially access to land. In cases where women cannot rely on their families to guarantee welfare for themselves and their children, they become increasingly independent and claim their share of the land. However, this situation increases the work load of these women, since they must manage all the household work and the field work, unless they have children to help in the fields.

WOMEN AND IRRIGATION PERIMETERS

The issue of women in relation to the irrigation project along the Senegal river valley is of great importance. Since consideration for land allocation is given only to the household as the beneficiary, women are considered as available labor to the family. They are not entitled to a piece of the family irrigated plot, which remains under the control of the husbands or the male members. However, the situation among the women differs in each of the irrigation projects.

In the Boghe project[3], the distribution of land was based on prior ownership rights. However, the amount of land that was made available to a family was reduced with the use of a complex conversion system to determine the amount of land allocated to each family. Thus many women were discriminated against in access to land in favor of men. Among the 722 farmers who participated in the project, only two participants were women.

The 29 women in Table 4 were the only female heads of households who, as registered landowners, received their land from their families or husband' families under the traditional system. An important case noted, a woman who had controlled the land of her deceased husband for many years under the traditional system. As she did not have male children, the brothers of her deceased husband, at the start of the project, took her land and gave her family only one plot of polyculture (0.25 ha) and not the plot of rice (0. 50 ha). Nevertheless, there were some women who had access to cultivable land from their brothers or uncles under the project as they had under the traditional system.

In another irrigation project, Foum-Gleita, women were considered as full active members and received the same share of land as men (0.25 ha/member). However, since the land was given to the household, many men felt that it belonged to them, and, in the case of divorce, women lost access to the land over which they never had control. Moreover, when the project created a women's vegetable garden cooperative, the husbands began to drive the women from the family plots, giving them access only to the garden plots. The lesson is that, even though the designers had a wonderful idea of allocating the same amount of land to each of the men and women per household, the creation of the women's garden destroyed for them possible access to family land unless they were single heads of households at the time of the distribution.

[3] The issue of land distribution by sex, caste and village in the Boghe Project was fully analyzed in Ngaido's Masters thesis. All the villages were surveyed, and the women who had access to land were also recorded to determine their participation.

In the small irrigation projects, women rarely have access to a plot. They usually receive a plot to garden as a married member of the village. Once divorced, they lose access to that plot.

In general, women were discriminated against accessing land in the modern irrigation projects because the land was allocated to the household and controlled by the male heads.

WOMEN AND VILLAGE GARDENS

Women's participation in village cooperative vegetable gardens has greatly increased in recent years. The gardens provide a useful complement to their family diet as well as a source of income. While women participate with a lot of enthusiasm, problems occur in the beginning as different members come to understand the meaning and purpose of the village gardens. Do village gardens become just another burden on women because they are now expected to provide vegetables for the family? Do they become a source of income for the women? If this is the case, the smallness of the plots does not allow the women to earn even 2000 UM/ season ($25). Is it just to provide women with a certain sense of property that will foster their awareness about property? Or is it a means to emancipate women in the rural areas? All these questions are of importance because the impact of the village gardens is beginning to be felt at the household level and at the village level. The villages involved in gardening in 1987 are shown in Table 5.

Table 5 shows that a total of 1376 women, nearly all the women in the village, were involved in village gardens. Access to the garden was open to all the women without any distinction of caste or status. If they participated when the garden was initiated, they were considered members, and they did not pay an entrance fee. If they did not participate in developing the gardens, they had to pay a fee to become a member. In the village of Woloum Nere, every new participant paid 1500 UM and in the villages of Bagodine and Ferralla, new participants paid 1000 UM. Also built into the system was a monthly and/or an annual fee that was paid by all the cooperative members. Sometimes, these gardens included women who lived in other regions of Mauritania but were from the specific village. They had an option to pay their entrance fee and have someone else cultivate their plots. This was a way of securing membership and maintaining access to a plot whenever they had to leave the village.

The major problem encountered with village gardens was that women did not understand the role that it was to have in their lives. As a consequence, many women did not fully participate, not only because of busy household activities but also because of a lack of motivation for community development. In all these villages, only the gardens in Bagodine seemed to be working properly. The other gardens have either closed down or ceased to function due to inadequate extension services or to internal conflicts among members.

When the Bagodine village garden was initiated in 1985, only 35 women participated. In two years, they improved the garden by digging two wells, fencing the perimeter and planting trees for a wind break. Presently there are 450 women who are divided into 45 groups of 10 women each. They grow a variety of vegetables from carrots to onions. The garden is divided into individual plots for which each member has to pay 100 UM per year ($1.25) for fertilizer, seeds and the upkeep of the garden. If a member fails to pay, she has to share her produce with the cooperative on a 50:50 basis. The cooperative took in 31,000 UM ($415.00) from annual fees in 1986 and 26,000 UM ($348.00) in 1987. The women participating in the village cooperative gardens receive between 600 and 700 UM ($8.00 to $9.50) in addition to the improvement of vegetables to complement their family's diet.

Although the garden in Bagodine is working better than other village gardens, it is still confronted with an inadequate extension service and a severe marketing problem. To resolve the latter problem, the women have considered buying a horse cart to transport their produce to two major towns nearby (Mbagne and Kaedi).

The village garden cooperative of Bagodine was recognized as a pre-cooperative by the Mauritanian Government, but the women are evolving into a community development organization rather than merely one that provides vegetables. This year they acquired a small diesel-engine-powered mill that has shown to be affordable to all the members of the cooperative. The mill has greatly reduced the women's work load in the households, allowing them more free time.

The success of the village garden in Bagodine is due essentially to the leaders of the cooperative who dealt effectively with all the issues that could have constrained garden development. For example, disputes among women hampered effective decision making and close cooperation. Therefore, they initiated a penalty system by which anyone who quarreled, no matter who was right or wrong, had to pay 200 UM ($3.00). From the cooperative leaders point of view, this penalty system improved management of the garden because women refrained from bringing their social conflicts into community development activities.

The village cooperative gardens constitute a good start for women to be involved in community development organization. Women are realizing that they can achieve something on their own. The incomes they receive, even when they are small, permit them to work with other women in the village and initiate new types of relations among themselves. This emerging awareness of their capabilities threatens male domination. In some villages husbands have asked their wives not to participate in the village gardens because the returns are too low to be worthwhile. However, when women do participate, men often rely or fall back on the women to provide the vegetables from these gardens without compensation.

CONCLUSION

The issue of women in development is very important, especially as the women are usually discriminated against when it comes to access to land. Even though women's access to land is an important one, the real issue is not the fact of being able to obtain land to cultivate but the organizational aspect and land holding customs of the extended family allowing or not allowing women access to land. It was found that all the women who were involved in either the *jeri* or the *walo* are widows, divorced women and women whose husbands migrated. There is one question that remains and needs to be answered. Can married women cultivate their own fields, given the fact that they have to work in their husband's field?

The paper examined the differences among women in terms of their status, their castes and their relationships to the land they cultivate. It is only by doing so that project developers can begin to understand the role of women and take into consideration the welfare of women and children while avoiding the same traps of past experiences.

This approach gives a new perspective in the way women's issues are analyzed, since women do not constitute an homogenous group. Every policy that is implemented may have adverse effects on some types of women who were not considered. Thus, any development project that deals with women's issues should differentiate according to the particularities of the population involved and avoid broad generalizations.

Along the Senegal river basin, the solution to discrimination against women with regard to land access may be dividing the land between the male and female shareholders. However, if married women get access to arable fields, we may witness a lot of sharecropping because they will not be able to carry out all the required activities (field and household) at the same time. It could, nevertheless, ensure the welfare of the women and their children because it would entitle women to private ownership rights without having to pay any land taxes. On the issue of welfare, the traditional system already has resolved this problem because women can have access to their land whenever they or their children need it, but they are both subject to land payments. Moreover, this adaptation under the traditional system allows all their children to obtain access to the family land. If the women were to ask for their share of the family land, then some of the children may be landshort or would have to participate on a one-year rotation system due to the fact that the women's share to the family is normally half that of the men's share.

Thus a major problem to agricultural development is that both these systems of land tenure will very likely lead to land fragmentation and the establishment of uneconomical size of plots. Studies have been suggested by international development organizations in order to find a satisfactory solution to this major constraint to agricultural development and especially to the issue of women in agriculture in the Senegal river valley.

Table 1: Women heads of households who cultivated the *jeri.*

Villages	Widows	Bar[1]	Divorced	Husbands migrated	Total
Woloum Haatar	6	2		1	9
Belel Gawde	1	1		4	6
Athene	6		1	7	14
Woloum Nere	7	4	1	7	19
Dioke	11			2	13
Lewe	3			4	7
Bagodine	3				3
Fondou	33	8	4	24	69
Niabina	8			8	16
Feralla	5	2	1	6	14
Mbahe	23	4	2	20	49
Roufi Awdi	1				1
Nereyel	3		2	2	7
Nere Walo	9	2	3	18	32
Dawalel	12	5	11	19	47
Total	131	28	25	122	306
Percent	43	9	8	40	100

[1]Remarried widows

Table 2: Women, castes and land ownership.

Class	Castes	Lessees	Owners	Total
Rimbe				
	torodo	5	25	30
	ceddo		2	2
	jawando		1	1
Nienbe				
	mabo	1	4	5
Jiabe				
	maccube	2		2
Total		8	32	40

Table 3: Women and tenure arrangements.

Tenure arrangements		Lessees	Owners	Total
herself	(1)		25	25 (62.5%)
dokal	(2)	4		4 (10%)
cioggu	(3)			0
rem-peccen	(4)	4	6	10 (25%)
(1&4)			1	1 (2.5%)
Total		8 (20%)	32 (80%)	40 (100%)

Table 4: Participation in the Boghe Project.

Villages	Male	Female
Boghe	181	10
Bakao	38	1
Ngorel	23	0
Sarandogou	41	1
Sae	43	1
Thialgou	80	2
Mballadji	19	0
Toulde	63	4
Thide	64	4
Thienel	38	0
Demett	44	2
Sinthiou	59	4
Total	693	29
Percent	96	4

Table 5: Women and village gardens.

Villages	No of participants	Fee for new members	Monthly fee	Annual fee
Athene	98	800 UM	10 UM	100 UM
Bagodine	450	1000 UM	100 UM	
Ferralla	130	1000 UM		250 UM
Mbahe	100			50 UM
Niabina	300		5 UM	
Woloum Nere	298	1500 UM	100 UM	
Total	1376			

ROLE OF WOMEN IN THE TRIBAL COMMUNITY FOR ECONOMIC DEVELOPMENT IN A FOREST-BASED MIXED FARMING SYSTEM

S. Rath, S. N. Das and A. K. Patnaik

BACKGROUND OF THE STUDY

India is a country of villages and farmers. Tribals constitute 15.75% of the population, and most of them live below the poverty line. Orissa is one of the backward states of India, having over 25% of the total tribal population who mostly reside in the rural areas. In India rural women are 80.92% of the total female population and 38.92% of the total population (685 million as per 1981 census). The total work force in rural areas was estimated in 1981 to be 228 million (constituting 45% of the rural population) of whom 82 million are women (representing 36% of the total rural labor force).

Women play a significant role in farming and farm management. A farm woman, whether tribal or non-tribal, is often the key person on whom the success or failure of the farm depends. The rural tribal farm women are efficient producers of the farm products. Even though they work in the villages for every minute of their working hours, there is still no guarantee that the food will be adequate for the family. The families who own a piece of land definitely eat a little better. The reason is that all the household labor, which means the women, is used to maximize the efficiency of the land while the men may go out and work for a wage. The cows or poultry that the family owns provide additional income.

In the forest setting, the tribal women have other work to do also. At times of scarcity of food, they go to the forest in search of readily edible or saleable materials that can save them from hunger (Bose, 1982).

Of late, both social and biological scientists feel that if any development at all in the country is to be brought about, the farmers of India should be given adequate reward for their hard work. It is not possible to bring about economic development on a sustained basis without improving the economic condition of the tribes.

At present in India, the priority has been given in the new 20-point program for its development, on "Justice to the Scheduled Castes and Scheduled Tribes" and on "equality for women."

Keeping this in view, the present study was designed with the following objectives:

1. to discover the work schedule of a tribal woman and the time use pattern in a tribal district;
2. to know the extent of involvement of women in cultivation of paddy and turmeric (a traditional crop), animal husbandry and other income-generating activities;
3. to identify how during the period of food scarcity on-farm research can help provide minimum food
4. resources; and
5. to learn how we can best reach the tribal women and bring them to the mainstream, using transfer of technology.

METHODOLOGY

The study was conducted by the Tribal Area Research Center (OUAT) in Phulbani in three developmental blocks having a large tribal population. Two villages from each block and 20 households from each village were selected randomly. Personal contact and interview methods were followed for the purpose of collection of relevant information from the tribal women (one active woman of the family was interviewed with the help of a structured interview schedule).

About Phulbani

Phulbani district was known as Boudh-Kondhmals and has two district sub-divisions on the basis of the topography. Boudh, the ravine plain situated on the bank of the river Mahanadi, and Kondhmals, a part of the eastern plateau predominantly inhabited by a primitive tribe called "Kondh."

[1] Director of Video Projects, Dean of Research/Extension and S.M.S. (Horticulture) UEBP.

This district of Orissa lies between 19°34' and 20°34' N latitude and 83°50' and 84°48' E longitude. The land surface of the district is gradually elevated towards the eastern-southern borders, and the highest plateau ranges from 1700' to 3500' from sea level. This district comprises an area of 11,070 km^2 with a population 717,280 as per 1981 census. The scheduled tribe and scheduled caste population of the districts are 279,276 and 133,077, respectively, 57% of the total population. Kondhas and Panos predominate the ST and SC population, respectively.

The climate is not healthy, especially in the hilly and forest tracts. The annual normal rainfall of Phulbani is 159.71 cm with 77 rainy days. The rainy season starts in June and ends in September.

This being the most backward district of the state, the tribals are generally poor, illiterate and conservative. Most of them are landless and depend on the *Podu* (slash and burn) method of cultivation and forest produce. Their standard of living is very poor. Most of them live in hilly tracts and dense forests and are still below the poverty line. Their average annual income from all sources is hardly over Rs. 1200 ($83) per year. They are mostly exploited by the local merchants and moneylenders (Sahukars) due to their illiteracy, ignorance and indebtedness.

Kondha women are hardworking and much more responsible than their male folk. Most days the male members spend their time in drinking wine, prepared either from salap juice *(Caryota urens* palm) or from mahula *(Madhuca indica),* and the women folk go to work in the field or collect forest products from the jungles that are required for their daily food. The daily activities of the tribal women are shown in Fig. l. On an average in Phulbani, a tribal woman works about 16.5 hours a day. Almost all the household activities and the bread-earning activities are done by her single handedly. Research studies in Rajasthan indicate that the average time devoted by women to agriculture operations is 8-9 hours in peak seasons in addition to her contribution in household and cattle care that consumes 4-5 hours of time per day (Lodha and Bhatnagar, 1986). Similar results have been found in Karnataka State, reported by Chakravorty (1984).

A tribal woman is the home maker. She has to collect food material, prepare the food and feed the family. She has to work on-farm or off-farm throughout the year. If there is scarcity of work, she is forced to go to the forest. For them no work means no food. It is even more precarious in the case of landless laborers.

Data have been presented in Fig. 2 that show how much time of the year a tribal woman gets work. This includes all sources including government programs. The figures reflect the most crucial periods of food scarcity. The availability of food includes all sources, namely their own farm produce, the food they purchase from their wages and food they collect from the forest.

Women go to the forest to collect food or readily saleable minor forest products. Figure 3 shows that the tribe depends on the forest throughout the year.

The above data show that when there is plenty of work available off-farm, there is also need for work on their own farm. The period of scarcity of food synchronizes with that period of heavy demand for labor. Either they have to go to work outside and earn wages or remain half-fed and work on farm. They are at a cross road. However, they adjust with the situation. September and October are the period of hunger, and in their words they call it *Pradisaki,* i.e. old hunger, and *Sakidanju* when there is nothing to eat and they die. At this stage the forest serves as the great storehouse for them. They regard the forest as God. Much as the land is to the farmer, so the forest is to the tribe.

Gradually the forests are becoming scarce in Phulbani. In 1978-79 about 84% of total area was under forest, but by 1987 only 53% was under forest. The total area under forest today is 5,856 km^2. To some extent the tribes are responsible for the reduction in forest area. The main cause for denudation of the forest is the slash and burn method of cultivation. The trees are cut and fires are lit. After the fire burns to ashes, cowpea, pigeon pea and in some cases paddy are seeded, depending upon the slope. This age-old practice continues. The tribe used to cultivate the land created by burning the forest for up to three years and after that they would leave it and switch over to some other patch. This practice usually helps the bushes to come up and the fertility of the soil is restored. Nowadays, year after year the same plot is cultivated; the productivity is lost, and the tribes are forced to seek other kinds of economic activity.

Phulbani has one specific rainy season, which is from June to September, and about 80% of the rain is received during this period. Quite a small area is under an irrigated cropping pattern; 4.48% of the total cultivated area (318,000 ha) is irrigated. Most of the cropping is done under rainfed farming system. But these days about 190,000 ha is taken after the local maize or kuiri *(Panicum millierie,* which is a minor millet). The demand for rice is increasing, and the tribal farmers arc interested in keeping every inch of cultivated area under paddy. Paddy is a risky crop for the upland under rainfed condition. The pressure on the women folk is increasing due to the paddy cultivation, which is very labor-intensive.

A study of the involvement of tribal women in paddy cultivation has been carried out in Phulbani district, which is reflected in Fig. 4 and Table 1. The period of labor intensity by months for paddy cultivation is also shown in Fig. 5. This shows that the demand on rice cultivation is increasing. Therefore, the labor demand is also increasing. It is also seen that the lean period of labor demand is crucial for tribals.

Another study reveals that most of the tribal farmers take a cash crop such as turmeric cultivation, which is labor-intensive. The duration of turmeric is 8-10 months. Sometimes the tribals keep it standing for the next year. Its cultivation is limited to 0.5 to 1.0 acre at best per family because the crop needs 5-6 tons of fresh green mulch, which is brought from the nearby forest by the women. The Sal leaves are mainly used for this purpose. Sal stumps are used as mulch for turmeric, but the cutting of Sal stumps is banned by the Government, which reduces the cultivation of turmeric. The participation of women in turmeric cultivation is 35%, as shown in Fig. 6, whereas the women's work in paddy cultivation stands at 57%. The total involvement of women in agriculture is more than 80%.

Kitchen gardening in the backyard is done by women. They generally store the seeds for the next season and know in which field what type of seed is to be sown. Except plowing, all other agricultural operations are mostly done by the tribal women (Dak et al., 1986).

Animal Husbandry Activities

Every day tribal women spend about 2.5 to 3 hours in animal husbandry activities. In this study the work has been categorized into two broad groups, namely regular and occasional (seasonal) activities. As a whole, men work more than the women in this sector. In summer the men take the animals for grazing and stay almost 7-8 hours away from home. In some cases they take the animals to the local veterinary hospitals and thereby involve themselves for a quite a long period. In the tribal community, drinking of milk is not very common. They seldom sell the milk in the market. They rear animals for draught power. Every household has poultry. In other parts of India the women's participation in animal products is the same as that in agriculture, i.e. more than 70-80% (Ram, 1987). But here the case is different. This result has been shown in Fig. 7 and Table 2. Women are involved up to 39% of the activities in both regular and seasonal activities.

Women work 2.45 min hours and men work 7 hours, especially when there are milk cows. In other cases the women's participation is almost the same as the men's in rearing animals. Besides dairy and poultry, sometimes they have pigs or goats. Men's involvement is more than that of women in those units (Dak et al., 1986).

The tribal woman is the manager of all the household activities and the saviour of the family at the time of distress. As has already been discussed, the rainy season and September-October are the period of scarcity of food for them. Hard cash is necessary during that time for their subsistence. The tribal women usually go to the forest and collect *Siali* leaves *(Bahunia bahai)* and prepare patravali (leaf plates), collect hill broom *(Thysanolen maxima)* sticks and make them into bundles. They also collect Mango, Jack fruit and wild minor fruits, such as Aonla, Perssimon, Ber and sometimes mushroom and process them before selling. These can be sold as such, but they get a very low price for this produce. Therefore, by doing additional work they earn a little more. They know that the moneylenders are waiting eagerly to purchase the raw materials, but they sell it after processing to increase the profit. They are very perfect in drying the fruits and vegetables. Their involvement in income-generating activities is shown in Fig. 8.

The tribals comprise 38.39% of the total population of the district. The density of population in Phulbani is 64/km^2 even though in some places it is only 16/km^2 while all of Orissa is 169/km^2. It is clear from this information that the villages are small and widely dispersed. The villages are amidst the forests, with an average of 141 to 5 persons per village. The tribes live deep in the forest. They are very shy, sober and hardworking and not amenable to sudden change. The tribes do not want to interact with the non-tribals, but during the market days they are exposed to the non-tribals.

Even though the women folk are the decision-makers in the family, they never come forward for discussion, even on the issues relating to their welfare. Even now they are practicing the same old method of farming. It is due to lack of education. About 68.66% of the sample are illiterate; 28.33% can read and write the local language but have no formal education, and only 14.97% have an education up to the primary level. Under the T and V system, the technology that is emerging from the research station of the University goes to the Subject Matter Specialists of the Department of Agriculture responsible for the extension. Step-by-step it is going down the ladder to the village agriculture worker who transmits his idea and understanding to the contact farmer. Here the technology remains trapped and docs not go beyond to other farmers. The question of technology reaching the women does not arise as there is no woman trainer who can interact with the illiterate tribal women. The tribal women are doing about 70-80% of the work involved in agriculture and animal husbandry in these remote corners, but they are neglected in the process of education of the farmers. It is evident from the

case studies that women are key persons in agriculture production.

Most of the time the resource-poor farmers need a better variety for dryland crops, marketing facilties and food during September-October. In one of such situations, 15 farmers were grouped by land holdings of 0.5 to 1.0 ha of marginal uplands. In trials of kuiri, local and improved variety (SS-1) released from the University, grown in side-by-side plots with their own farming practices, the average yield obtained varied from 2.375 - 3.125 q/ha (SS-1) and 1.250 to 1.500 q/ha (local), as shown in Table 3. With this increase in yield, the improved variety replaced the local variety not only in that village but in the nearby villages. This replacement was from the farmer to the farmer (Rath, 1987).

This kuiri experience is also noted in other crops such as paddy (short duration). To bring about any change over the traditional activity is a very difficult task. Until the tribal women are satisfied with and accept the technology, they are reluctant to change. Unlike the general extension programs, FSR/E brings about change as the farmer herself does the experiment with her own resources and becomes more conscious that the technology is for her betterment and welfare.

Most of the time if the visitor goes to the tribal village, he will find only children and old men and women. A study was done on the involvement of the villager in extension programs. The objective was to determine the percentage of the population of men and women attending the extension programs in the villages. The data have been shown in Table 4.

The data include the active and passive participation in meeting and exhibitions. It is desirable to develop scripts in their language and show modern technology and practices through the video so that during the time of entertainment they can learn new ideas. Even though the women are doing about 80% of the work in agriculture, they are not acknowledged in extension meetings (Verma, 1984). If proper facilities are provided, they will be the most sought after and the audience will participate with a better understanding.

SUMMARY

In the tribal areas of Phulbani District, we have studied the role of women to better understand the forest-based, mixed farming system. In this process, we have learned about a number of indigenous technologies that we are now testing in tribal areas elsewhere in Orissa.

Also, with a better understanding of the agro-ecological factors in the area, we have been able to introduce aromatic grasses that serve to stabilize deforested land areas. These grasses are perennial and have become well-established. While originally seen as a useful soil conservation technology, their additional commercial value has enabled the tribal villages to establish a small rural industrial factory to extract the oil from the lenon grass and palmarosa grasses that were planted. Women cut the grasses and bring them to the extractor. This new economic activity has given a 100% income increase (from about Rs.3000/ha to nearly Rs.7000/ha) to the farm families involved. About 25 families are now benefiting. Many other tribal families are now growing the aromatic grasses and have applied for loans for the extraction equipment. There is a ready export market for the aromatic oils and an economic gain of Rs.50-100/liter produced.

Since we learned through our research about the scarce food period in the area, emphasis has been given to developing improved varieties of kuiri so that there will be adequate food resources for families until paddy and maize harvest.

The research sub-station in Phulbani continues to address the needs of the tribal families in the area through studies of land utilization and attention to increasing the intensity of food cropping.

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Table 1 . Involvement of labor in paddy cultivation in Phulbani.

Operations	Men	Women	Total
Land preparation and nursery	10	-	10
Seed treatment, seed sowing transplanting	2	13	15
Incultural operations	5	15	20
Irrigation fertilizer application	3	-	3
Plant protection	3	-	3
Harvesting, thrashing, bagging	5	10	15
Marketing and processing	2	2	4
Total	30	40	70

Table 2. Role of tribal women in animal husbandry activities in Phulbani district in Orissa.

Occasional (hours)		Activities	Regular (hours)	
		Regular / brooding including collection of fodder, procurement of feed and mixing	M W	½ 1
M	7-6 hours	Taking the animals for grazing Cleaning of the shed	M W	3-4 ½
M	5-6 hours	Health care		
		Care of the calf / chick	M W	½ $^3/_2$
		Milking / collection of eggs, processing	M W	½ ¼
W	2-3 hours Market day	Marketing of dairy/poultry products such as ghee and yogurt	M W	1 - ½ ¼

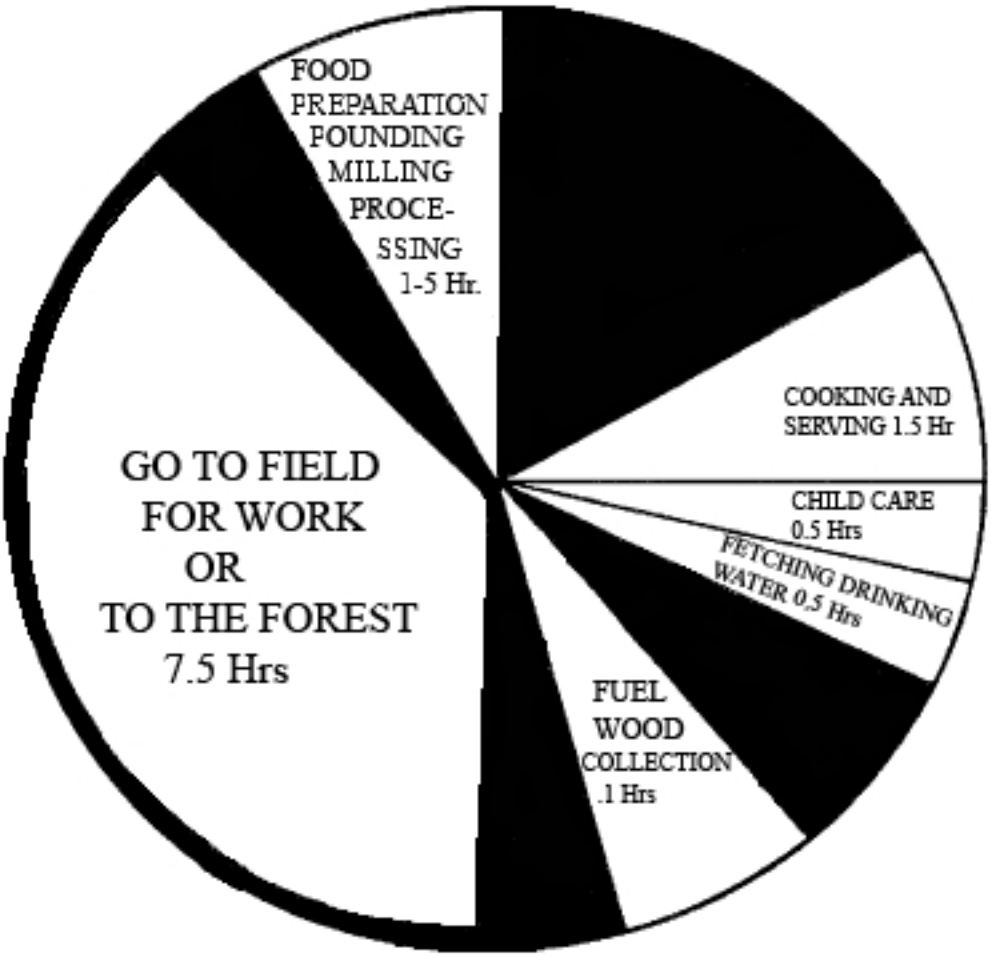
Table 3. Average yield of Kuiri in Phulbandi.

Name of the village	Number of farmers	Yield in q/ha			
		1985-86		1986-87	
		Local	SS-1	Local	SS-1
Beradapadar	8	1.250	2.625	1.500	3.125
Muskili	7	1.250	2.375	1.375	2.875

Table 4. Percentage of farmers attending the extension worker in the village.

Mode of contact	During day		During evening		Whole day	
	Men	Women	Men	Women	Men	Women
	%					
Face to face	10	-	30	-	-	-
Farmers day Kissan mela etc.					30	10
Group discussions	30	10	40	15	-	-
Mass contact with audiovisual aids	35	30	90	92	-	-
Exhibition (Mobile)	25	15	75	80	-	-
Exhibition in (Market days)	60	45	-	-	-	-

Fig. 1. WORK SCHEDULE OF TRIBAL WOMEN
IN PHULBANI
(TOTAL WORKING HOURS 16.5/DAY



TOTAL 16.5 HOURS

Fig. 2. AVAILABILITY OF WORK AND FOOD TO THE TRIBALS IN PHULSANI (BY MONTH)

	AVAILABILITY OF WORK FROM ALL SOURCES			AVAILIABILITY OF FOOD FROM ALL SOURCES		
MONTH	ON FARM	OFF FARM	ANY OTHER WORK	OWN FARM	FOOD PURCHASED BY USING WAGES	FOREST
JANUARY	●	● ●	● ●	● ● ●	● ●	● ●
FEBRUARY	●	● ●	● ●	●	● ●	●
MARCH	●	● ● ●	● ● ●	●	● ● ●	●
APRIL		●	● ●	●	● ●	● ●
MAY	●	●	● ●	●	● ●	● ●
JUNE	● ●	●		●	●	● ●
JULY	● ● ●	● ● ●			● ●	●
AUGUST	● ● ●	● ● ●			● ●	●
SEPTEMBER	●	●				●
OCTOBER	●	●				●
NOVEMBER	● ● ●	●	●	● ●	●	●
DECEMBER	● ●	●	● ●	● ●	● ●	●

● LITTLE WORK
● ● AVERAGE WORK
● ● ● PLENTY OF WORK

● LITTLE FOOD
● ● AVERAGE FOOD
● ● ● PLENTY OF FOOD

FARM (0.5 - hr)

Fig. 3 AVAILABILITY OF FOREST PRODUCE FOR TRIBALS IN PHULBANI (BY MONTH)

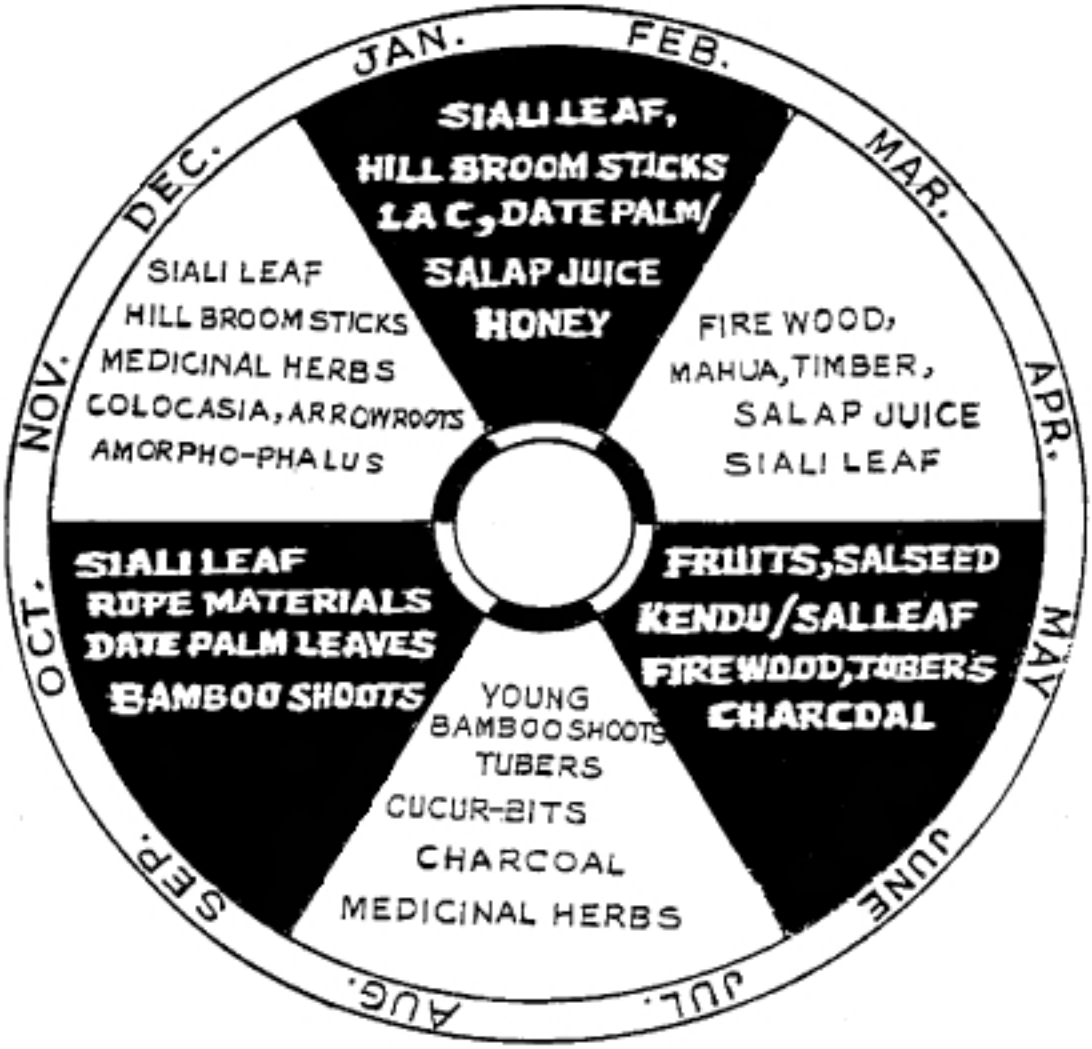
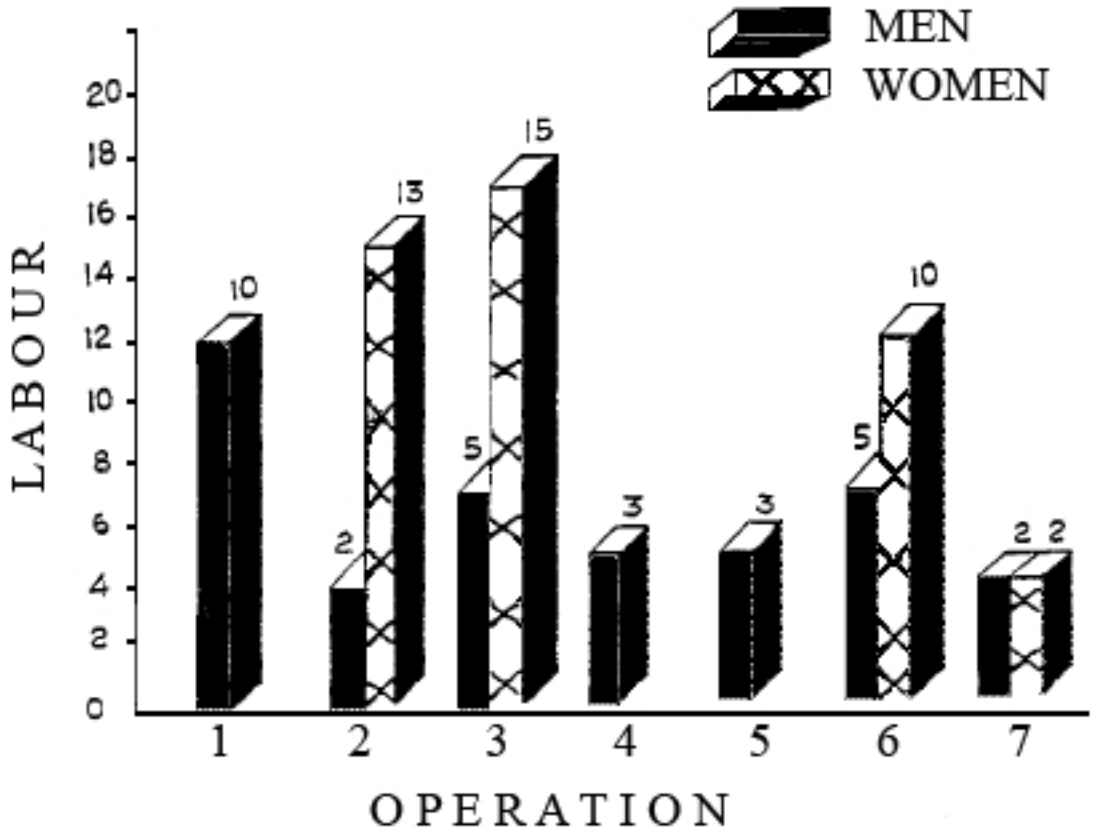


Fig. 4. INVOLVEMENT OF LABOR FOR PADDY CULTIVATION IN PHULBANI BY OPERATION (TOTAL 70 / ac / SEASON)



1 - LAND PREPARATION AND NURSERY
2 - SEED TREATMENTS, SOWING & TRANSPLANTING
3 - INTERCULTURE
4 - PLANT PROTECTION
5 - IRRIGATION
6 - HARVESTING, THRESHING, BAGGING
7 - PROCESSING AND MARKETING

Fig.5. INVOLVEMENT OF LABOR FOR PADDY CULTIVATION IN PHULBANI BY MONTH

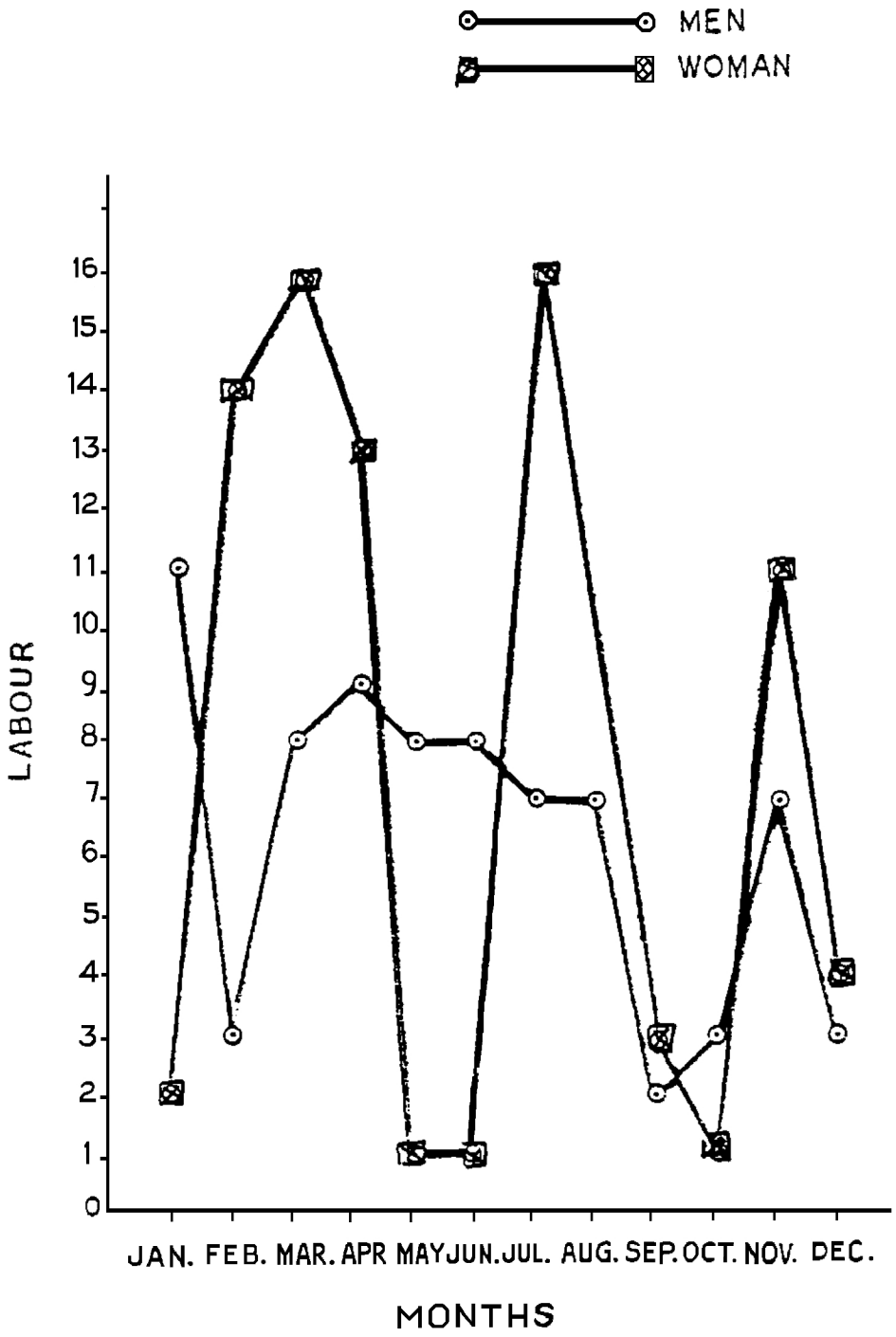


Fig. 6. INOLVEMENT OF LABOUR IN TURMERIC CULTIVATION IN PHULBANI BY OPERATION [TOTAL 145 / YEAR/CROP]

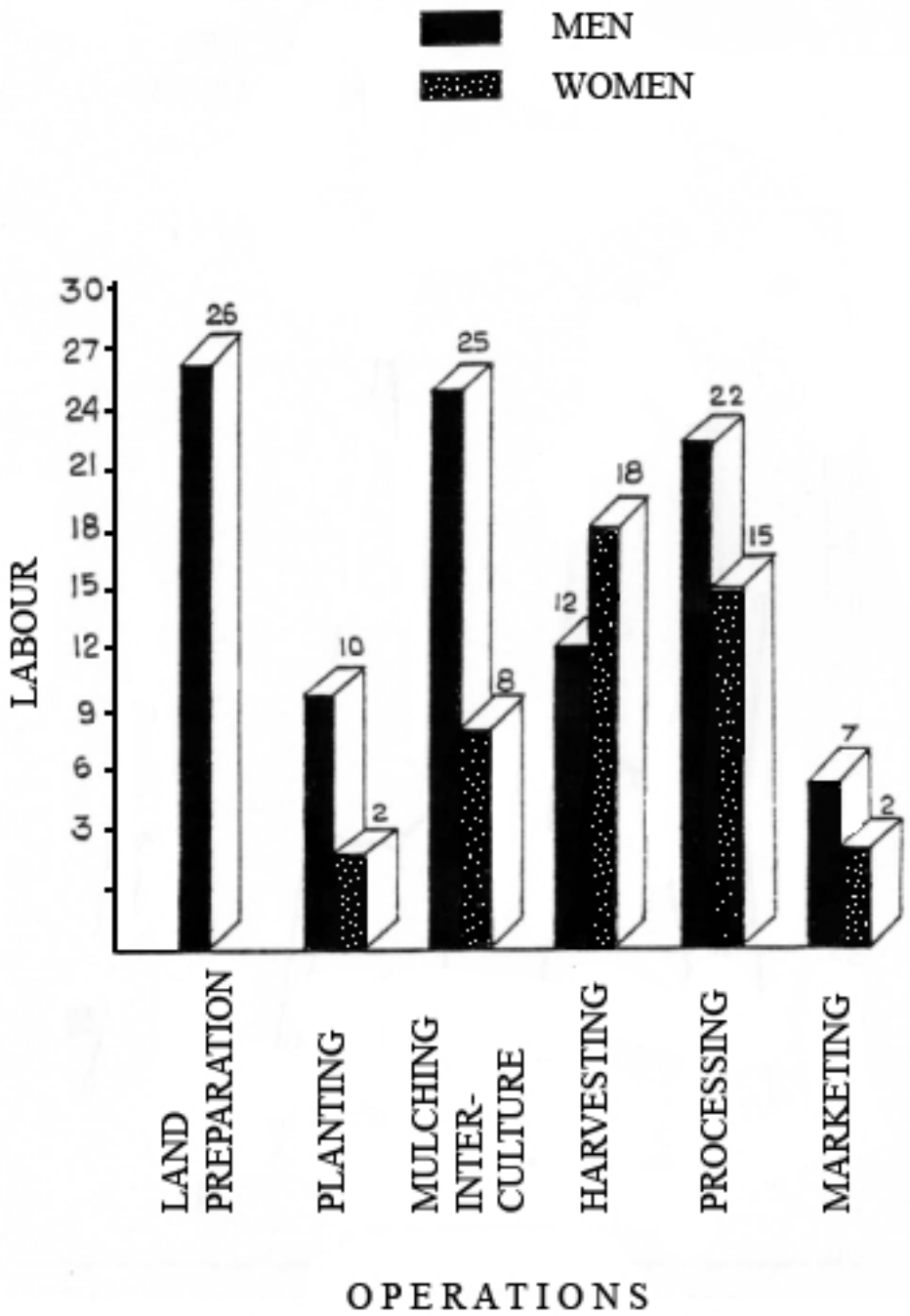


Fig. 7. INVOLVEMENT OF LABOR IN ANIMALHUSBANDRY ACTIVITIES IN PHULBANI

[IN THE FAMILIES THOSE HAVE MILK COWS]

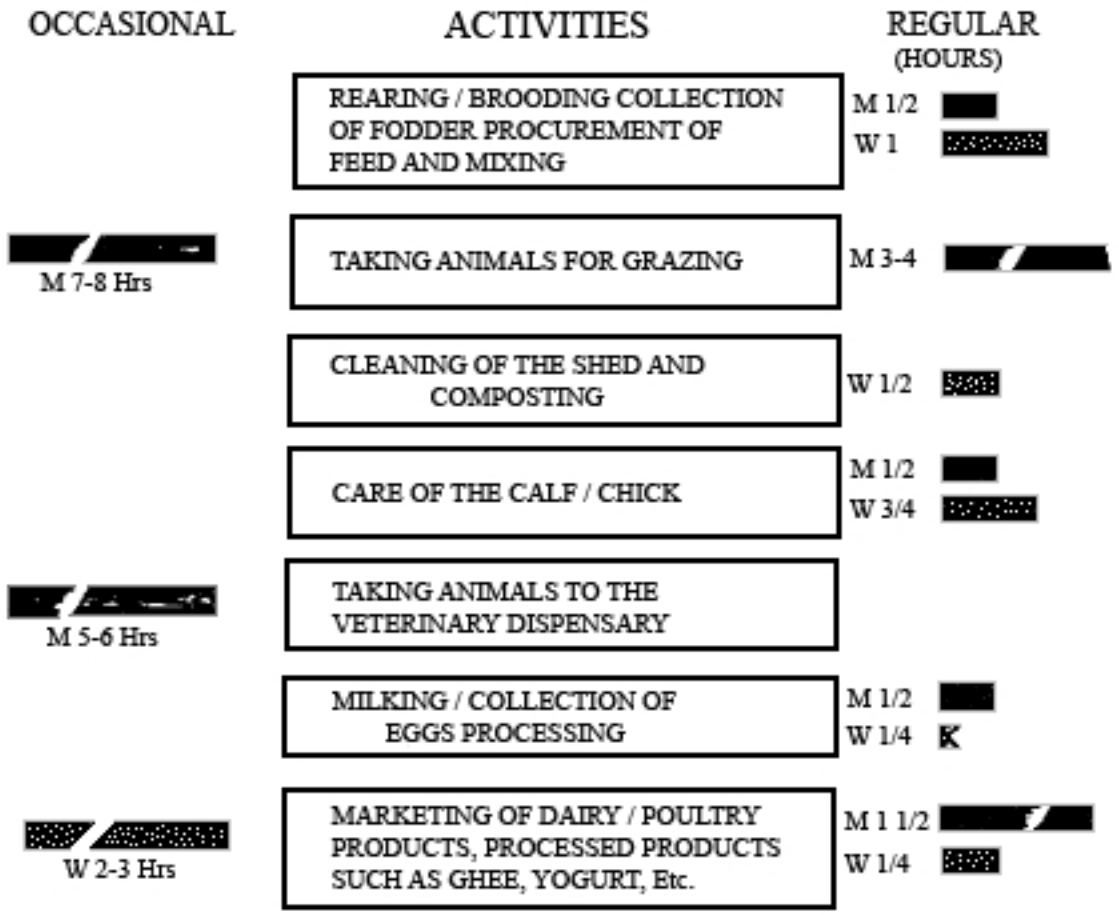
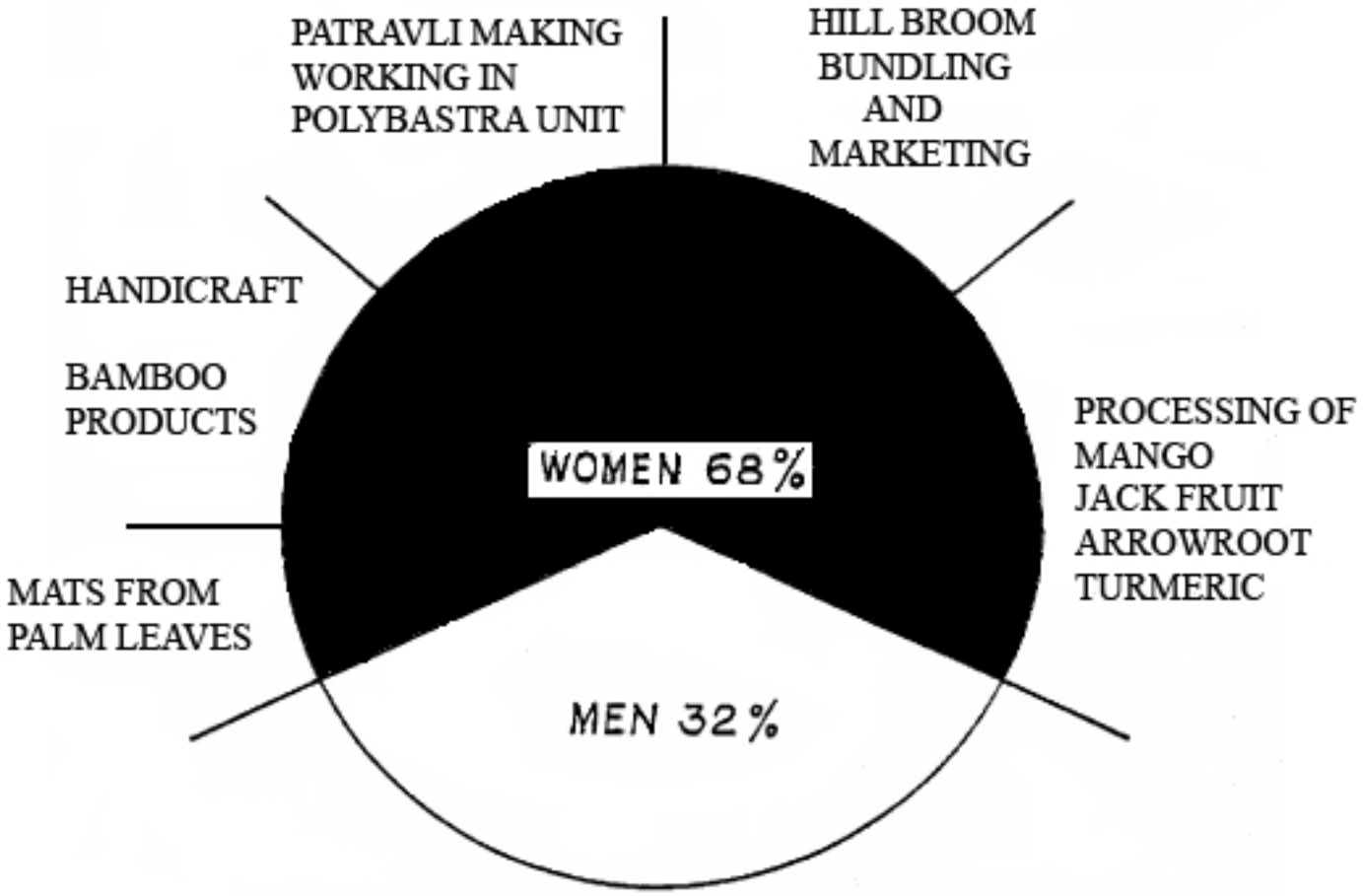


Fig. 8. INVOLVEMENT OF TRIBAL WOMEN IN INCOME GENERATING ACTIVITIES IN PHULBANI



ROPE MAKING, BAMBOO PRODUCTS, MUSICAL INSTRUMENTS.
AGRICULTURAL IMPLEMENTS
ERICULTURE, SERICULTURE, HONEY & LAC PROCESSING

APPLICATION OF GENDER ANALYSIS IN A FARMING SYSTEMS RESEARCH PROJECT: A CASE IN BAN DON POR DAENG, KHON KAEN, THAILAND

Nongluk Suphanchaimat[1], Samneing Viriyasiri[2], Wilaiwatt Grisanaputi[1] and Nupin Sutava[2]

INTRODUCTION

Most rice-based farming systems in Southeast Asia are still subsistence under rainfed conditions. At a given traditional technology, labor has remained a crucial factor of production. In addition, in certain areas such as Northeast Thailand where rainfall is erratic, the seasonal out-migration of men is increasing both domestically and internationally. Under such circumstances, farm labor at peak seasons can be severely deficient, especially for households where male laborers are absent. In a country where there is no social stigma attached to employment by gender, male and female labor tends to be interchangeable. In situations such as this, it can be expected that women will play a significant role in farming as well as in maintaining a livelihood.

If women and men are expected to contribute equally to the economic well-being of the family, it is essential that both benefit from the technology development process. This paper illustrates efforts to make women beneficiaries of technologies in an on-going research project in Northeast Thailand.

THE PROJECT AT BAN DON POR DAENG, AMPHUR BAN PHAI, KHON KAEN, THAILAND

The Crop-Livestock integrated farming systems project at Khon Kaen province was financed by the Thai government and the International Development Research Center of Canada (IDRC), which has a strong international linkage with the Asian Rice Farming Systems Network (ARFSN) coordinated by the International Rice Research Institute (IRRI), Philippines. This four-year project started in 1984 and was conducted to establish integration between Department of Livestock Development, Office of Agricultural Economics, Farming Systems Institute and Khon Kaen University. The general objectives of the project were to encourage collaboration between the concerned organizations and to develop methodologies for integrated crop-livestock systems research. The specific objectives were

1. to develop suitable cropping patterns, including backyard forage crops, appropriate to integrated livestock production;
2. to examine the effects of feeding farm by-products on the production of draught/beef cattle and dairy calves;
3. to measure the performance of alternative technologies in the farm environment;
4. to compare alternative technologies and production systems with existing systems in terms of biological productivity, farm resource use efficiency and farmers' preference;
5. to identify the labor, cash and agricultural inputs needed for the alternative technologies;
6. to identify potential resource conflicts at the farm or community level caused by alternative technologies.

The project was composed of three working groups: (a) cropping, (b) livestock and (c) socio-economic. To achieve the above-mentioned objectives, the crop and livestock groups conducted crop trials and tested the use of crop residues for animal feeds. The major recommended crops grown in upland and upper paddy were peanuts or sweet corn followed by cowpeas whereas direct seeding of rice was tested at the lower paddy areas. However, this was not successful due to drought stress for two consecutive years. Peanut residues were found to be the best suited crop residues for animal feeds. However, residues of upland crops such as cowpeas and corn were also used by the farmers to feed their animals.

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DESCRIPTION OF THE SITE

The crop livestock integrated farming systems project was located at Ban Don Por Daeng, which is 50 km southwest of Khon Kaen. The village is accessible by paved road, which is approximately 15 km from the highway. Vehicles commute to Ban Phai township daily. The village had no electricity until 1988 (Fig. 1).

Agroclimatic Characteristics

The village depends on the monsoon rains that come as early as May, but the peak level of rainfall comes around September. The average rainfall for the districts over the past 20 years is about 1100 mm annually. However, the village rainfall pattern over the last three years (1984-1986) shows an erratic rainfall pattern with an average of 852 mm/year (Fig. 2). The drought stress situation in this locale had reduced the rice planting area, especially in the upper paddy, by approximately 40% in the 1987/88 crop year.

Topography and Soil Type

Areas of this village are moderately undulating from the east to the west. The low paddies are located near the La Wa River, which overflows during a good rainy season. After the irrigation department constructed a weir (dam) near the village of Ban Don Por Daeng, the villagers claimed that approximately 64 ha of low paddy fields were permanently flooded, reducing the area for rice production and grazing fields for draft animals. The east side of the village is mostly upper paddy and upland fields of rice and cassava. The common problems in this area are inadequate water supply for rice production, infertile lands and spotty saline soil (Fig. 3).

Cropping Patterns and Cultural Practices

Farmers at Ban Don Por Daeng grow both glutinous and non-glutinous rice in paddy fields during the rainy season. Glutinous rice is produced mainly for staple food while non-glutinous is for occasional cooking and for sale. In the upland areas, cassava is the main crop for cash with kenaf as another competing crop. Corn, melon and peanuts are also grown in small areas.

Mulberry is a common crop grown in upland areas. The majority of households grow approximately 0.08 ha of mulberry. Traditionally, this crop is planted with minimum spacing and no pruning, enabling it to withstand drought but lessening its productivity. The average rice yield during a good year is about 320 kg/rai (2.02 ton/ha) (Fig. 4). Farmers use a local rice variety and HYV (RD 6) with minimum chemical fertilizer usage. Approximately 18% of the farmers reported using some chemical fertilizers and pesticides and, if their land is near La Wa River (OAE, 1984), a water pump.

Animal Production

In general, farmers in this village raise water buffaloes for animal labor and cattle for sales. Swine raising is limited to farmers who also have rice mills in the village. Native chickens are also common in every farming household, but they are raised mainly for home consumption. When the project first started in the village in 1984, there were at least five farmers who raised dairy cattle. The project supported these farmers with technical information concerning production. However, the dairy farmers faced severe marketing problems and feed shortages due to drought in 1986 and had to sell all their dairy cows.

A report from the Office of Agricultural Economics in 1984 revealed that on the average, farmers raised 2 buffaloes, 4 head of cattle, 13 native chickens and 8 ducks (OAE, 1984). High cash inputs such as medicine and materials for artificial insemination were used for large animals whereas minimal cash inputs were used for poultry production.

General Socio-Economic Conditions of the Villagers

The project organized 22 contact farmers out of 162 in the village. Information on the general condition of the contact farmers was collected by the project socio-economic group. It was reported that on average the contact farmers held 31.64 rai (app. 5 ha) of agricultural land per household; 63% of the area was low paddy, 15% was upper paddy, and 22% was classified as upland. Average household size was about 6.64 people/ household with four working laborers, two male and two female (14-60 years of age).

The heads of households averaged 41 years of age and four years of schooling. Although the use of family labor was predominantly in cultivation, hired labor was employed during the peak season, and exchange labor was commonly used in rice threshing. Water buffaloes were the main source of draft power for land preparation. Machinery was commonly hired for land preparation in the upland areas for cassava production at

an average cost of $25.00/ha. Most farm households cultivated rice mainly for home consumption. Their supplementary cash income was derived from cassava and kenaf cultivation, silkworm rearing, silkcloth-weaving, wage labor in nearby areas and remittances from off-farm activities.

IDENTIFICATION OF WOMEN'S ROLES IN AGRICULTURAL PRODUCTION

During the initial stage of the project, a benchmark survey was carried out by the crop-livestock team to collect information about the village and households and crop and animal production. In addition, farm household data were collected on a daily basis, but the information on labor utilization was analyzed in aggregate form. There was a lack of information on specific tasks and activities by gender and age group. The labor data collected by the Office of Agricultural Economics were not analyzed by crop enterprise or by operation.

In 1986 a team of social scientists from Khon Kaen University joined the crop-livestock team to conduct gender analysis and integrate women's concerns into the research activities in collaboration with research staff from Farming Research Systems Institute. In order to identify gender roles in crop production activities, the social scientists re-analyzed the labor contributions of family members according to crop enterprise, crop operation, gender and age.

Daily record keeping revealed that, on the average, female laborers contributed nearly as much labor as male laborers in crop production with a slightly higher percentage in vegetable gardening (46%:54%). Men engaged more in large animal production (75%:25%). Additional information from informal interviews indicates that free grazing is still a common practice of large animal raising in this area. Generally, men (especially young male laborers) are responsible for grazing the large animals as they can also hunt at the same time. Although female workers appear to contribute less in large animal production, they participate in caring, feeding for the animals and gathering forage such as grasses by the cut and carry method. It is a common sight to see women herding cattle in the fields. Both male and female labor appear to be about equal in poultry production (45%:55%). Women normally help in feeding the chickens and cleaning the pens. Men engage in the buying and selling of native chickens since this activity takes place at night when all the chickens are housed in the pens.

In terms of labor hours, handicrafts such as silkcloth weaving and mat-making are female-dominated enterprises (80%:20%). Deep water fishing at the nearby river, being very time consuming, is predominantly done by men (92%:8%). Women and children, however, supplement in gathering natural foods such as small fish, crabs, frogs and tadpoles with the use of lighter equipment such as lift nets, strainer nets and hand traps.

Another important source of income is through working as hired labor at other farms. It is shown that both men and women are equally engaged in waged labor activities (48%:52%). It is interesting to note that wage earning opportunities are available. As indicated in the previous section, men and women have equal opportunities to obtain off-farm work. The common off-farm work available in the village is weeding and harvesting in cassava or sugarcane fields. Farmers of both sexes receive the same daily wage of about $1-1.25 for weeding and harvesting cassava while wages in the sugarcane plantation are paid by piece rate (Table 1).

In the 1986/87 crop year, the project's cropping system working group conducted 5 cropping pattern trials in 40 plots (approximately 6 ha of planted areas) distributed among 22 contact farmers. The project provided technical expertise and cash inputs while contact farmers were required to provide land, labor, livestock and tools for cultivation. This is one way to share resource costs and subjective risks as well as to speed the adoption process as long as such subsidies do not become permanent. Household members participated in the activities of the crop trials. Most contact farmers asked their son or daughter to help in crop trials, depending upon their availability. Research assistants stationed at the site recorded the names of the household members who were involved in the crop activities and the time spent for each work day. From these notes it was possible for the team to construct farm labor participation by crop activity, gender and age.

Information in Tables 2 and 3 reveals that females participate more in planting and weeding activities while males participate more in land preparation, pesticide application and harvesting cassava. However, in house-holds where male labor was not available, female labor was used in pesticide application. Similarly, female farmers were often found to substitute in land preparation when male labor was absent or inadequate (in case of large farms). Thus, it is possible to conclude from the crop trial information that female laborers are increasingly important in carrying on crop cultivation. Interestingly, harvesting cassava from the trials appeared to be dominated by male labor as compared to corn or peanuts harvesting since all cassava were immediately transported to the town for sale after harvesting. In addition, in upland cultivation, land preparation is increasingly done through the use of tractors.

IDENTIFICATION OF CONSTRAINTS

Besides working for wages in nearby villages, laborers in the Northeast are generally engaged in seasonal migration to urban sectors, particularly in the central plain. Seasonal migrant laborers are either young men and women or married men. These laborers migrate seasonally to work in other parts of the country, usually returning to their homes to work on farms during rice planting and harvesting season or for other family obligations such as sickness in the family, wife confinement or simply to bring home money or goods (Paranakian, 1981).

At Ban Don Por Daeng, however, migration to work in other areas is different from the general seasonal labor movement. In 1987, there were 73 households out of 162 that had at least one male laborer who migrated (51.2% were household heads whose age ranged from 31-40 years). The rest were either sons or sons-in-law whose ages ranged from 21-30 years old. With male labor absent from the households, it is expected that females, especially the wife, will have to work harder, and there must be some adjustment in decision-making processes. One of the major constraints in the crop-livestock project activities was the increasing out-migration of male labor and inattention to the important role of women in these activities.

Major findings from a recent migration study in Ban Don Por Daeng revealed that the wives whose husbands migrated to the Middle East had to participate more in crop and livestock activities, although more hired labor for farm work was evident. In households with either a son or son-in-law who migrated, the farm tasks they used to do were done by the other family members. The lack of labor discouraged farming families from participating in crop activities that required intensive labor inputs.

For those who engaged in large animal production, at least 50% of the respondents reported that they had to sell their animals not only due to the absence of labor to take care of the animals but also for transportation expenses abroad.

The wives of migrant workers reported that, left to manage the household affairs, they sometimes sought help from their parents or relatives. However, decisions on investments (e.g. house construction and children's education) or on borrowing money were jointly made with their husbands through correspondence.

In addition to a high out-migration rate in the village, most farmers suffered greatly from severe drought. It was evident that in 1985-1987, average rainfall of about 800 mm/year was way below the normal average/year of 1,100 mm. Therefore, the team indicated that possible crop technologies would have to be highly drought resistant and suited to limited family labor.

With these constraints, however, one activity that seemed to provide livelihood to women in both farm and homestead was silkworm production and silk cloth weaving. When mulberry leaves, which provide feed for the silkworms, are in limited supply due to low yields, women go in groups and buy from nearby villages. With these constraints, the team thought of technologies in both mulberry production and silkworm rearing.

IDENTIFICATION OF TECHNOLOGY OPTIONS TO ENHANCE WOMEN'S PRODUCTIVE CAPACITY

Most mulberry gardens in the village are traditionally grown with minimum spacing, local variety and no pruning. The average area of mulberry garden is 0.5 rai (0.08 ha); thus the supply of mulberry leaves in the village is quite limited.

The team therefore suggested that the project should introduce improved mulberry gardening in the village. Ten farming families were first selected as contact farmers for this project. High-yielding varieties of mulberry trees were provided to farmers involved in the experiment. At least 0.16 ha was required. The recommended cultivation is 1.2 m^2 planting space with annual pruning in March. During the first year of planting, either peanuts or corn were selected by the farmers for inter-crop between rows of mulberry. Manure fertilizer was applied twice a year. Average peanut yields were about 150 kg of fresh pods per rai. Peanut residues were used for animal feeds. Farmers who grew corn intercropped with mulberry earned approximately $12 of corn sales per family.

Almost all farmers started using the new mulberry leaves for silkworm rearing after rice was harvested at the end of 1987 crop year. Farmers rearing traditional silk worm strains could produce approximately 0.5 kg of silk thread at a yield of about $15 per cycle. Farmers usually rear silkworm 5-6 cycles/year. Compared to the local hybrid strain, the local silk worm strain has lower yields but is more disease resistant. An increase in silk production through better rearing techniques is being recommended by the Silk Experiment Station at Khon Kaen. However, it is necessary that women be trained with improved cultural practices, particularly sanitation.

The team discovered that in the following year, the women cooperators distributed the high-yielding variety of mulberry to other interested mulberry growers. They reported that the new technique of mulberry planting not only provided higher leaf production but also saved time in picking leaves since planting in rows provided more work space. With an adequate supply of mulberry leaves, women cooperators are better able to sustain silkworm rearing for additional household income.

TECHNOLOGY TESTING

The project is now into the technology testing phase. Two groups of families (ten each) are selected as cooperators of the project. One group will serve as the control group (using traditional silkworms) and the other as experimental group (using hybrid silkworms). Production, time use and income data will be monitored from both groups for comparison of the cost and benefits of the existing and improved practice. Training will be conducted regularly to facilitate transfer of technologies and develop the skills of women.

SUMMARY

In Northeast Thailand rice and non-rice cultivation suffered severe drought for two to three consecutive years. Farming in this environment became very risky. This led to the increased migration of male labor to the Middle East and a shortage of labor in farming activities. Women in this area were left to manage the household and farm and to seek alternative income opportunities. Among the alternative activities, silkworm rearing and weaving of silk cloth became important and livelihood-sustaining activities of women. Through gender analysis and understanding of women's roles in farm and non-farm activities, technologies in mulberry and silkworm production are now being tested by a multidisciplinary team from different agricultural research institutions and universities.

This initial experience illustrates a team effort to integrate women's concerns into a farming systems research project and also demonstrates the use of gender analysis in technology development through farming systems research.

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3. Paranakian, K. 1981. Rural families with dislocated males: Effects of urban male migration on female members left in the village. A country report, a case of Thailand, Office of Regional Advisor for Social Sciences UNESCO Regional Office for Education in Asia and the Pacific, Bangkok, Thailand.

Table 1. Proportion of time spent in various enterprises, by gender.

Enterprises	Percent of total	
	Male	Female
Rice	58.95	41.05
Upland	50.00	50.00
Vegetable garden	46.65	53.35
Livestock	74.58	25.42
Poultry	45.00	55.00
Handicraft	20.55	79.45
Fishing	92.25	7.75
Wage labor	47.99	52.01

Table 2. Proportion of labor by gender in 1986 crop trials.

	Rice		Corn		Mung Bean		Peanuts	
Activity	M	F	M	F	M	F	M	F
Land preparation	100.00	-	85.39	14.61	68.45	31.55	79.78	20.22
Planting	36.46	63.54	38.77	61.23	29.97	70.03	41.08	58.92
Weeding	21.43	78.57	39.22	60.78	22.66	77.34	34.31	65.69
Apply fertilizer	100.00	-	50.00	50.00	-	-	46.05	53.95
Apply pesticide	-	-	84.87	15.13	-	100.00[1]	94.29	5.71
Harvest	crop failure due to drought		5.19	94.81	46.85	53.15	46.85	53.15
Average total	31.65	68.35	44.40	55.60	49.62	50.38	51.08	48.92

[1]Female substitution due to male absence.

Table 3. Proportion of labor by gender in inter-cropping 1986 trials.

	Cassava + peanuts		Cassava + corn	
Activity	Male	Female	Male	Female
Land preparation	54.55	45.45	92.31	7.69
Planting	34.26	65.74	10.14	89.86
Weeding	26.32	73.68	37.04	62.92
Apply fertilizer	50.00	50.00	-	-
Apply pesticide	-	-	100.00	-
Harvesting	63.15	36.85	76.20	23.80
Average total	31.10	68.90	64.66	35.34

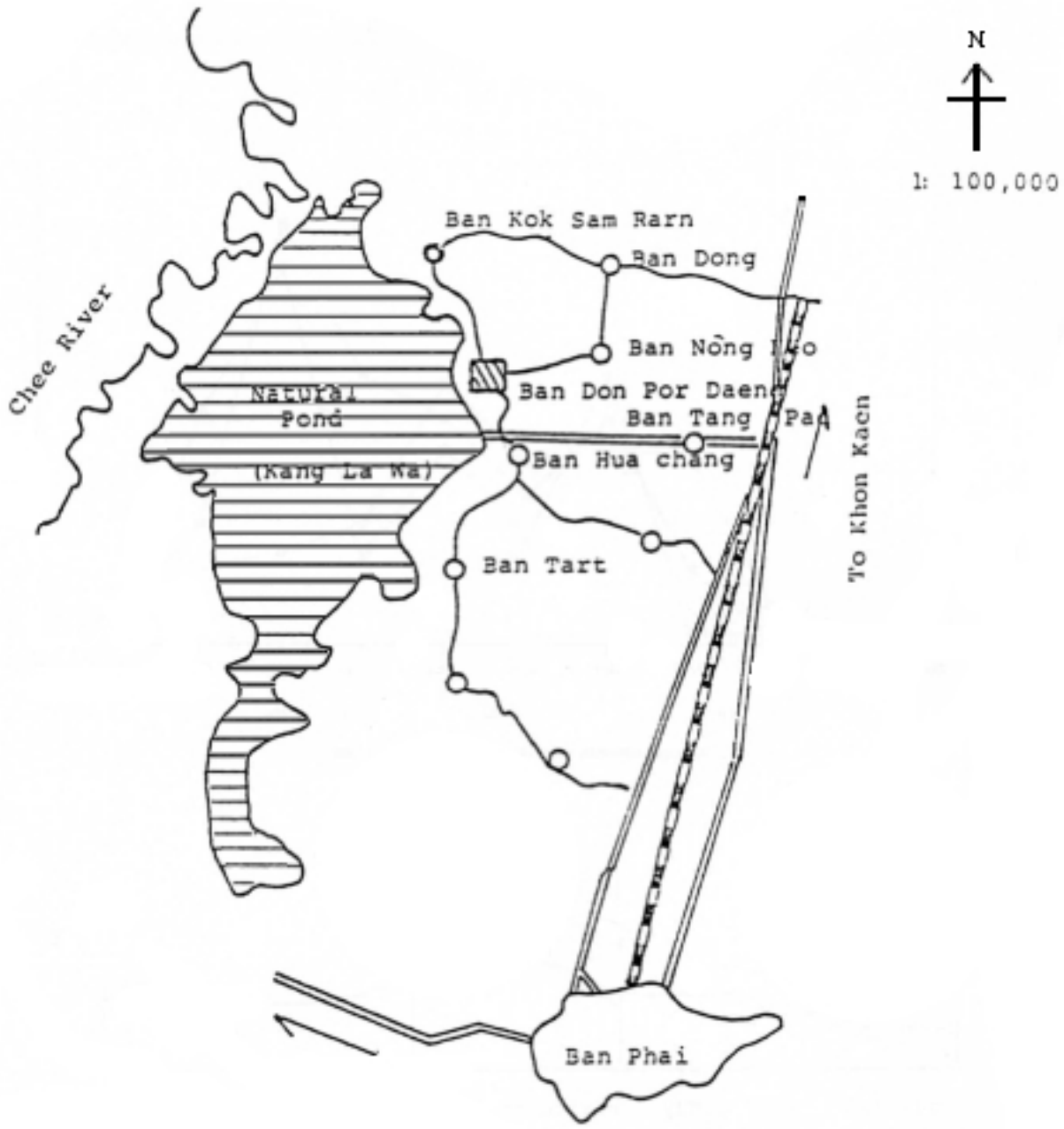

Fig. 1. Map showing site at Ban Don Por Daeng, Ban Phai, Khon Kean.

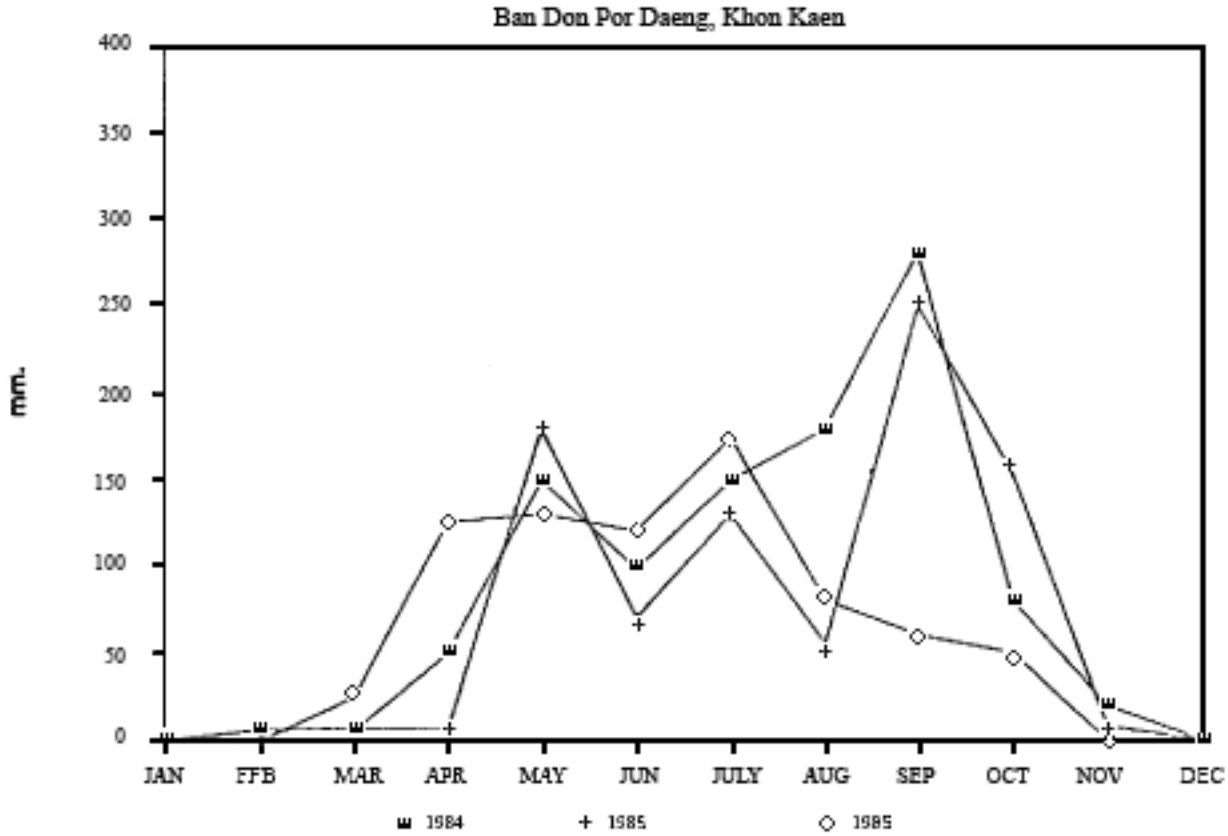

Fig. 2. Average montly rainfall (mm) during 1984 - 1986.

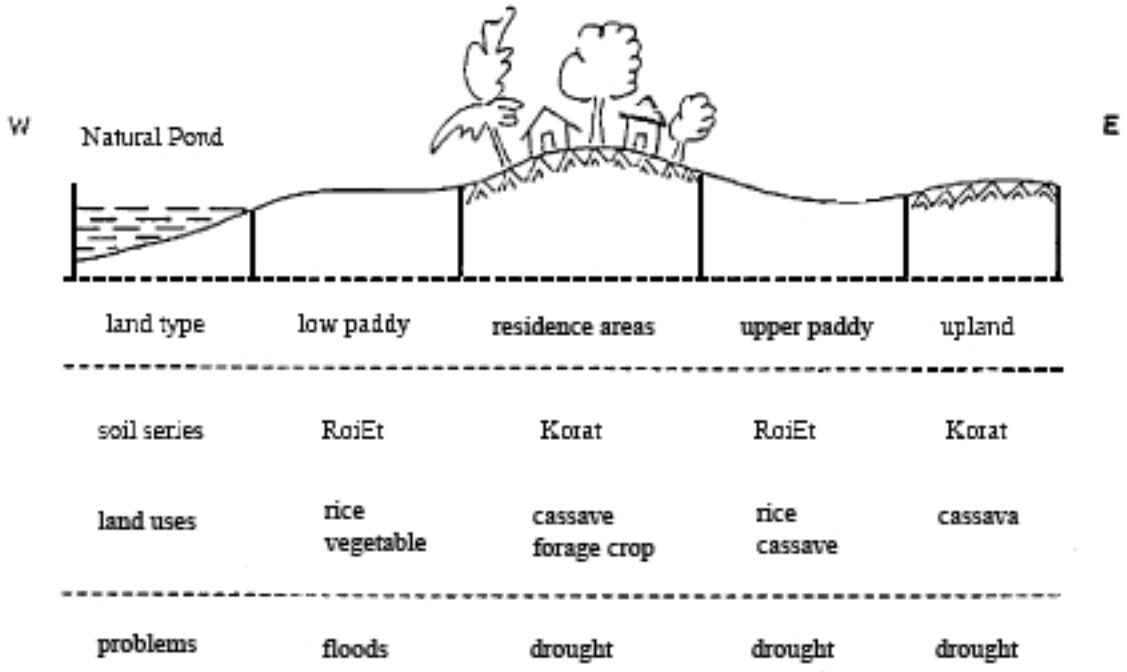

Fig. 3. Cross-section of topography at Ban Don Por Daeng. Source: KKU-FSR, 1988.

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                    Month
Crop        A   M   J   J   A   S   O   N   D   J   F   M

Rice                    ****************************

Cassava     ****************************************************

Kenaf       ******************************

Corn        ******************

Mellon      ******************

Peanuts                     ***************

Mulberry    *prunning*                      **planting**
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Fig. 4. Crop calendar of Ban Don Por Daeng in 1984

Global Papers:

The Role of Information/ Communication Systems in FSR/E

BACK TO THE FUTURE:
THE POWER OF COMMUNICATION AND INFORMATION

James W. King and Charles A. Francis[1]

INTRODUCTION

The information revolution has arrived. We have become an information and service-based society. The US communication industry controls public opinion, and thus we are products of the media. Even information is power. What do these perceptions mean, and how do they affect our planning and strategies for tomorrow's agriculture?

We have heard that FSR/E is nothing more than common sense practical extension work, or a re-naming of the Balanced Fanning Program once used in Missouri. Some say that sustainable or low-input agriculture sounds like a return to labor-intensive farming without fertilizers and chemical pesticides. The new national extension system initiatives are viewed by some as administrators putting new titles on old programs in order to secure continued funding.

These are all examples of the power of information-or perhaps the power of "mis-information"-and how communication or lack of same can cause severely distorted impressions of what some current activities really involve.

In contrast to these gross simplifications, we propose that FSR/E does provide new forms to today's practical extension programs. FSR/E methods allow efficient and participatory implementation of the new initiatives. We see this as an approach to greater use of crop rotations, maximum exploitation of internal and renewable resources and appropriate dependence on the principles of soil and land stewardship for long-term productivity Better use of information from new programs helps us to sort through the clichés and search for meaning in a complex situation.

We could call this a vision of "Back to the Future, " an apparent oxymoron. It indicates a forward-looking perspective well based on indigenous wisdom and practices. It integrates the most practical technical advances in biology, ecology, agronomy, animal science, pest management, engineering and social, economic and human development. The science and practice of communication is used to organize process and package data and messages into useful information to promote the sharing of meaning. This leads to our short-term outcome, a more sustainable agricultural production system, which can help provide food and fiber for the long term.

There is power in information and in communication. There is influence in the use of that power. We are agents of change and advocates of the process of education to implement change. One of our missions is to foster a capacity for change in the groups with which we work. Those who practice "Fanning Systems Research and Extension" are already deeply involved with communication and information. We want to share some principles, describe emerging concepts and present practical examples of the process working.

WHAT ARE THE COMPONENTS OF INFORMATION?

Communication is a process. It is the process of sharing meaning. Meaning is developed by audiences in response to messages and data they receive. Communication is continuous and ongoing. "You do not start a communication process-you engage in an activity already underway" (Hilleman, 1988).

We may think that what we say and write is information. To the person who creates a seminar or bulletin, this is information. For that person, uncertainty has been reduced; the data are meaningful. However, what we say and write is not immediately information for the person who receives it. What we say and write are messages, constructed and designed from data.

In the communication arena, data are symbols that represent facts, events or things (Day et al., 1988). Thus words, visuals and graphics are data. For FSR/E, they represent agricultural facts, events or things.

Messages are data that are structured and sent. Messages are words, the extension guides, the visuals and the television programs we design to communicate with selected and targeted audiences.

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Information is not an autonomous entity, as an object, event or thing, it does not exist. Information is developed in the minds of the audience after they are exposed to either data or messages.

Communication researchers and educational technologists have often defined information as anything that reduces uncertainty (Harries, 1972; Shannon and Weaver, 1949). If data or messages do not reduce the uncertainty an individual has, they are not information. When data and messages do reduce the uncertainty and individual has, they become information for that individual.

While we will not list and explain all the ingredients of communication and information systems, there are other communication and information elements to examine, including the concept of participation.

Participation is a key factor in the emerging communication paradigm. The participation notion fuels the entire FSR/E effort. (See Horton and Prain [1988] for a discussion of participation in one on-farm research project.) We embrace the concept of audience participation in the communication process and seek new and innovative ways to involve our audiences in several key aspects of communication.

First, we must extend gathering baseline data on the system, including current information status and needs. Our target audiences can aid the interpretation and meaning of our data. We must also incorporate our audiences or samples in the design and development of messages and media selection. We need to better use our audiences in evaluating our communication efforts. This is the feedback component.

Feedback is the audience response after exposure to our messages. Feedback may or may not tell us if the audience understood our message, changed its attitudes or developed new behaviors. Used in FSR/E programming, evaluation and research provide formal feedback mechanisms. With these techniques we can demonstrate the impact and effectiveness of our communication programs and of our entire farming systems' effort.

Given all the research and data available on sustainable agriculture, have we achieved an informed society (Ellul, 1985; Van Cuilenberg, 1987)? Jackson (1987) at the Land Institute in Kansas argues that indeed we are not well informed. Rather we are experiencing an information implosion. In part, we are losing and may have already lost many kinds of indigenous skills and information because there is so much "new" in our lives.

INFORMATION: UNIQUE AS AN INTERNAL RESOURCE

Locally occurring, farm-derived data and messages are internal information (Francis, 1986; Francis and King, 1988b). It occurs and renews on or near the farm and is very localized in its impact. Past experience with one hybrid or specific planting density is an example. This experience is a natural resource, so to speak. External information, on the other hand, is from off the farm, from commercial or research sources; it normally is not locally based. A federal USDA bulletin on tillage methods would be an example. Both types of information are necessary for successful crop production, and both types of information make demands on individuals. Most farming systems employ a mix of these two types of information inputs. Even the most isolated farm or community seeks and gets new information about new varieties or techniques. The most externally-based information-seeking systems depend in part on local information for feedback.

The contrast between internal and external information is useful for FSR/E and sustainable agriculture. Precise information about the efficient application of internal information to crop production issues can be used to increase their relative importance. Use of local information on crop and pest biology and interaction among components can provide the basis for a shift in reliance from external information to internal resources (Francis and King, 1988a). Once new data and messages are digested and incorporated into the local management model, external materials are in fact transformed into an internal resource.

All of these data and messages are important. But as Bennet (1986) points out, we may unintentionally imply that knowledge or information generated off-farm is superior to the indigenous knowledge of the farmer in an ongoing, on-farm system. We believe that internal information is the key to future agricultural success.

Information is a resource that continues to grow when shared. "Exogenous knowledge becomes 'indigenous'" (Bennet, 1986). Havelock et al. (1969) noted that innovative systems (farmers) are open, willing to accept and share data and messages. To the extent that the data and messages reduce uncertainty, they become internal information and help the system (farmer's knowledge base) develop and grow.

Information, then, is anything that reduces uncertainty-messages, data or observation, for example. Information is the opposite of uncertainty. Most of us abhor uncertainty; therefore, we continuously seek information by eliminating possibilities and evaluating probabilities (Fuglesang, 1982). We attempt to put order on the complexity of the communication environment in which we find ourselves. We relate new data to old patterns, we rethink old messages to determine if new meanings are emerging, and we shape our behavior on both past and present data and messages (King and Brubaker, 1979, 1980; McGregor, 1967). For example, Nebraska farmers eagerly anticipate the new university uniform corn test books each year.

WHAT IS DIFFERENT ABOUT TODAY'S ENVIRONMENT?

Compared with the past, there are major contrasts in today's information and communication environment These differences greatly influence our clients and the way we relate to them.

Recently, Wake et al. (1988) in an article on agricultural learning portrayed the current agricultural environment as complex, variable and diverse. Today's communication environment echoes this description.

So, what is different? First is the sheer volume of data and messages from a multiplicity of sources that reach the farm and decision maker each day. There are a large number of message sources and data on types of hybrid seed corn available or the alternative chemicals used to control certain insect or weed problems. Our clients have a big challenge. They must decide how to screen the quantity of incoming material and how to evaluate these many sources and decide which are relevant to a local situation and profitable within the operation.

Often messages or data are in dispute. Sometimes two sources of information are in conflict. A corn company may recommend the longest possible hybrid maturity to achieve maximum potential yield, while the extension service suggests cutting back 10 days on maturity to use available degree days for natural drying of the crop to save money. A chemical company may recommend application of corn rootworm insecticide to assure freedom from this pest, while a crop consultant suggests crop rotation to avoid both the pest and the money spent on unnecessary control. Recommendations for one section of the country may not apply in another. They are unlikely to be useful in another climatic situation in another country. The localization of data and messages (sent as a designed recommendation) is becoming more feasible with new communication techniques. This challenges our farming systems community.

Our clients are data seekers, but they need great control to access points in the system. At the same time that farmers need more access to information, they need to screen both sources and individual messages to efficiently decide what to assimilate. To the traditional information sources are added non-conventional products and dimensions: alternative soil fertility amendments, biological pest control products, environmental, health and safety issues. This is indeed a complex communication environment.

Multi-media messages presently are bombarding the agricultural sector. Many resources are dedicated to advertising products that supposedly will make crop or animal enterprises more efficient or more profitable. We are rapidly reaching the point at which the advertising budget for a chemical herbicide may approximate that for a certain brand of deodorant or hamburgers. These are slick and convincing messages. We need to promote a high degree of sophistication in our clients who have to be able to group and grade these messages. This is a complex and competitive arena, and one in which we must move in a pro-active and spirited way.

NATURE OF INFORMATION TODAY

There are also characteristics of "information" (Marchello, 1987) that become part of the communication environment.

- Information is a creatable resource. It is not used up when used. The audience will change in some way after receiving data and messages. New approaches will also be required for the production and distribution of the future's data and messages.
- Information is expandable. It grows with application, and in the process new data and messages are created.
- Information is diffusive. Data and messages are perhaps more awkward to confine and command than are other agricultural resources.
- Information is transportable. Data and messages can be transmitted anywhere owing to the computer and electronics revolution in telecommunications and video.
- Information is substitutable. We have argued elsewhere that information can substitute for purchased inputs (Frances and King, 1987, 1988 a, b; King and Francis 1988).
- Information is shareable. The nature of agricultural data and messages is such that they call for exchange transactions, two-way communication, feedback.

Yet, when we start planning our communication efforts, we often venture forth with misconceptions and misinterpretations not only about communication and information but about our audiences. These we are calling communication "fallacies" (Dolbe, 1987).

WHAT ARE SOME COMMUNICATION FALLACIES?

All of us involved in the communication process have misrepresentations and misunderstandings with respect to our target audiences.

We may assume that "little knowledge of terms means little understanding of concepts.... "(Dolbe, 1987). Many times in the planning phase we will discuss certain issues using precise terms. We receive blank looks from our audience. We then jump to a conclusion: people do not understand the terms that relate to the proposition; therefore, they do not grasp the proposition.

For example, an audience may not relate to a basic discussion of "nutrient cycling in a system which employs progressive biological structuring for resource uptake efficiency." The same audience may relate well to nitrogen contribution of soybeans or alfalfa to maize in rotation.

The first fallacy then is "…mistaking ignorance of terms for ignorance about the concepts to which the terms relate" (Dolbe, 1987). There are more.

"Women in the US know very little about production agriculture; therefore, they must have little interest in it." There are many assumptions here about what the audience knows and in what they are interested. We typically assume that "limited knowledge about an issue implies little interest in it" (Dolbe, 1987). The extension of this misconception is this: since people don't understand a situation, they can be disregarded.

Recent experiences with Nebraska extension programs designed for "Women in Agriculture" belie the conventional wisdom. Women at times have been more able to conceptualize the entire farming operation and how it may be improved, while men are concentrating on the specific production practices and short-term management decisions.

From a FSR/E perspective, we should know this and be sensitive when we design our communication strategies. People regularly have an avid concern about a problem, "but not as the issue is formulated and discussed by experts" (Dolbe, 1987). People define issues themselves. We need to formulate an issue as our clients see and formulate the issue in order for communication to succeed.

The language we use in our surveys, the way we design our meetings, the types of invitations we develop to announce programs, the choice of visuals we incorporate into our presentation all help to frame the issue. People may or may not respond to our construct of the issue.

Our point is this: when people don't immediately respond to our stated issues, it doesn't mean they don't care. Rather, they may define the problem differently, based on their own involvement or their own work view.

Another communication fallacy relates to opinion. We may believe that agricultural or rural opinion is inconsistent; in fact, we may feel that it is so inconsistent that it does not influence decision making (Dolbe, 1987). When we ask our audiences open ended questions, we receive a wide range of responses. In this situation, there is a tendency to conclude that the impressions are inconsistent. Based on their perception of inconsistency, we conclude we can't reach solutions; thus we act on what we feel.

There are many opinions on weed management-extension specialists and farmers talk about weed control We harbor a conventional opinion that fields must be absolutely weed free, and that "control" is a synonymous with "herbicide use." In fact, the modern approach to weed management includes crop rotations, weed indices, band application and cultivation, all as part of "integrated pest management."

Dolbe (1987) says that "there is often an understandable rationale" for public inconsistency. We need to verbalize the "rationale" from a communication perspective. We can help our audiences become aware of and "work through" issues. They will then reach better or different decisions.

In our example, the issue is managing weeds and not rate of needed herbicide. Audiences may need more data and messages, credible data and local messages, time to study the data and messages, timely and manageable data and messages, credible sources and opportunities to provide input.

IDEAS ABOUT COMMUNICATION

There are several ideas about communication that will help us better understand information. The first of these ideas relates to influence, meaning and reality (Bettinghaus and Miller, 1973).

1. We communicate to influence to the behavior of others. All the messages and data communicated among people have purpose. The basic purpose is to influence a behavioral response. That is, the message may encourage a person to buy something new, continue to buy something old, change a particular farming practice, integrate a new technique into an existing operation or a variety of other behaviors. We all communicate to influence others to act in certain ways.

2. Meanings are in people, not in words or visuals. Words and visuals have intended meanings, but the receivers of the message actually supply their own meanings. This is because the receivers are examining the materials in light of their own experiences and their own farming systems. Munoz (1986) discussed these ideas in his study on comprehension of pictorial messages among farmers. Audiences relate the visual and verbal messages to their existing knowledge about a topic.

   Today we have another interesting problem with meaning. Klapp (1982) suggests that meanings are lagging behind the actual communication. There is such an increased volume of messages and data that people are "slow" in forming meanings and information for all the input stimulation. One way they handle this complexity is that they substitute meaning; they use lower quality meaning as compensation for lost meaning. This includes the desire of people to be told answers-the request for a product to solve a problem-rather than the desire to develop in each individual a problem-solving style, a process approach based on gathering the data and relating it to their own farming situations (Francis et al., 1987).
3. Reality is subjective; we create our own realities. We often assume that what exists for us is interpreted in exactly the same way by everyone. People tend to distort, ignore or avoid incoming messages that do not conform with their particular points of view. For example, researchers who work with small plots and extrapolate to large-scale systems may not understand why farmers may view the results of these "garden plots" skeptically.

FSR/E researchers must find, use and possibly restructure the indigenous knowledge of the existing agricultural sector. People have internal knowledge about their own systems. We need to be learners about that knowledge and "retrieve what people have learned on their own and get it fed into the system for testing and possible use elsewhere" (Lionberger, 1986).

There is another communication area that can provide strategies for FRS/E designers. This is the area of perception, the ways in which we experience or become instantaneously familiar with our environment (Fleming and Levie, 1978). Perception is important for our communication efforts. The better our environment and the relationship among things are perceived, the better they can be remembered. Proper attention to perception will help us design our communication so it has less opportunity to be misunderstood. Finally, perception is important because we often replace the real work, our fields and our crops, with substitutes such as printed materials and visuals. It is very important to properly depict those realities.

Perception is relative rather than absolute: people make judgments about things by comparing or estimating. This year's crop becomes a standard by which we judge next year's crop. The quality of our soybeans is compared to the standard at the experiment station demonstration plot. We know that messages that are interesting to the audience are perceived as comparatively short in duration. We know that we can "chunk" and divide difficult messages, such as cropping concepts, into small, easy steps.

Perception is selective: we cannot attend to everything in the environment, so FSR/E must help design the communication environment. The number of agricultural items and concepts to be discussed must be limited. Complex processes such as multiple cropping systems with trees can be presented point by point. Words and visuals can direct our clients to select, or perceive, the important aspects of a demonstration.

Perception is organized: people like organized communication. FSR/E can design messages that exhibit organization by numbering the steps in a demonstration of a process or by giving verbal clues such as before-after, greater-lesser, either-or, next. Planting cycles can be organized by using question-raising messages.

Perception is influenced by expectations: what we expect to see or hear slants what we do attend to how we organize and understand it. Communication can set audience expectations by providing directions and instructions. "Notice this plant... "Objectives and topic sentences help audiences focus on what comes after. "Our task today is to..." "There are three simple procedures in harvesting this crop..." From a process or problem solving approach, open-ended questions can be used. "What do you think happened in this field?" "Why?" "Guess."

With these ideas on communication, how can we better design our messages to communicate with our audiences? Understanding begins with observation (Strassmann, 1985), and we now want to share ways to look at our audiences and our messages that help clients make management decisions that have maximum applicability to their own farming systems.

WHAT DOES AN AUDIENCE EXPECT TODAY?

We will be discussing audiences and their expectations from what Wake et al. (1988) would call informational learning-learning by information [sic]. Today's agricultural audiences are better educated, highly motivated and perhaps more pessimistic about what they hear than our past clients. We need to design innovative and understandable approaches to reach these groups.

Groups may appear passive in their reception of messages-slide talks, printed recommendations or television/video presentations. However, we find from experience that audience involvement is one of the keys to successful teaching. Any direct challenge to thinking, evaluation and active response will help to promote this involvement and enhance the learning process. We need to recognize that learning is a multi-faceted process-- that the teacher is also a student/learner and the students, or farmers in this case, have much to offer to the teacher and to each other as a part of the process. Education is more than a two-way street-it's a complex road map of interconnecting streets and pathways along which messages and data can flow under the right conditions. Information will result. This could be called a new paradigm in communication as it relates to farming systems and the sharing of information. One teaching/learning approach being used by the Extension System-- United States Department of Agriculture is the experiential approach (International Training Division, nd.) based on the work of Kolb (1978) (Kolb and Baker, 1982; McCaffery, 1984).

To understand audience expectations and their interplay with the communication environment, we can look to research on human learning and message design. Combining this research with prior experience will guide our designing of messages targeted to our audiences.

A number of authors have studied cognitive learning processes (Cowan and Fordyce, 1987; Fleming, 1980, 1987; Fleming and Levie, 1978; Van Patten, et al., 1986; Salisbury, et al., 1985). These ideas have been related to training and agricultural situations (King, 1986; King and Francis, 1988; King and Rockwell, 1988).

Patterns of Learning

Cowan and Fordyce (1987) reported on learning and cultural influences. Their studies indicate that "there may be appreciable differences in perceptions of learning, habits of students, and problem solving." No one is correct and no one is wrong; these differences are just different ways of perceiving the same situation.

Perceptions of learning. In some cultures, knowledge structure is viewed as something external to, outside of, and maybe apart from the individual. Knowledge is not discovered; authority figures transmit knowledge to the individual. An individual's task in the learning environment is to assimilate knowledge in a manner personally appropriate, but in routine order. A contrasting knowledge structure is one that develops from an individual's exploration of data, events and messages. Content, interpretation and ultimate meaning and application are in the individual's domain.

An example of the first case is farmer acceptance of a maize hybrid X-123 based on recommendation by the local sales representative. This is rote learning, an unconditional acceptance of what to plant based on trust, past experience or some special affiliation with that company or dealer. In contrast, the farmer who carefully studies the hybrids from several companies, their characteristics and potential application in the immediate farm system follows a learning process that is personally relevant.

Learning habits. In some cultural systems, learners seek an authority, a person or text, in the learning situation. The "master" will provide direction. There is little urging for exploration. Credible data and messages come from outside the individual. Prepackaged messages, a product approach, is preferred.

Small farmers in the highlands of Kenya were urged to buy seed of new maize hybrids. They were also advised by large posters of the best time to weed and exactly what fertilizer to apply. There is no dialogue, and recommendations were assumed to be uniform and absolute.

In other situations, learners strive for independence; they become data seekers. They question authority, want second opinions and use multiple data sources. Process is integrated with the product approach.

Problem solving. Culture seems to influence the entire conceptualization of problem solving strategies. In some instances, problem solving stems from a problem assessment. Suitable tactics are selected; individuals invent some of the plans themselves, especially if the situation they face is new or innovative.

In other instances, problem solving is described as the "purposeful application of knowledge structures which have been studied, comprehended and mastered" (Cowan and Fordyce, 1987). This seems to be an excellent example of process versus product approaches.

Audience Requirements

Fleming (1980) identified four stages an audience uses to learn and gather data more effectively: stimulation, meaning, order and strategy. Within the context of promoting the farming systems perspective (King and Rockwell, 1988), we discuss each of these.

Stimulation. The first challenge is to get people to a meeting, tour, field day or demonstration-and our projects compete with many other potential activities on the farmer's work and social agenda. A number of devices have been used to stimulate attendance: offer of a free meal, distribution of seed, demonstration of a new technique, release of a new variety or hybrid.

Location of the event may provide incentive if the activity is on a research station, at a prominent farmer's home, in the local school demonstration garden. Other incentives may include transportation, free materials, information, seed or production mini packages. These types of stimulation are culture and language specific and need to be carefully thought out during organization of the activity.

Diverse audiences have limited sensitivities and perceptions of what is to be learned. Without an optimal level of external stimulation in a program, people develop ways of enduring the situation without learning much. If a presentation is not stimulation, the audience's attention may wander, and some will fall asleep. If a presentation is too stimulating, people may miss the real message.

Farming systems' message designers must use a variety of stimulation techniques in developing a stimulating program. Color, pacing, motion, voice level, visuals and print should all be woven together to present an exciting message. Hands-on participation can help promote continued attention to the topic at hand. Farmers may be given the opportunity to evaluate a series of maize or bean varieties and see how their ratings compare to the rest of the group. People could be invited to physically select and harvest ears or pods from the best plants in a field and to keep the seed to take home-one way to teach selection and disseminate seed of a new variety at the same time.

In India, farmers were shown seed increase plots of new dwarf varieties of wheat. They were admonished not to take any seed under any circumstance. Tour leaders then turned their backs with the full expectation that alert farmers would take several heads in their pockets and increase the new variety at home.

Methods for stimulation will vary with crop, with system and with culture. A stimulating message and approach can attract and keep the audience's attention and promote an exciting learning situation.

Meaning. The second important concern of our audience is to incorporate meaning. Although the data and messages need to be linked to things familiar to the audience, several devices are useful to provide continued stimulation. Complex, novel, uncertain, dissonant and even aversive information and methods of presentation can be used to stimulate Extension audiences. Meaning must be balanced with stimulation, and the relevance of the data must be obvious throughout a presentation.

A message for farmers on the environmental impacts of clean tillage needs to be understandable and not too complex. A simple demonstration of soil erosion from a hillside with the resulting gullies in the field and silting in of a canal or ditch at the bottom has meaning to farmers, while detailed discussion of the universal soil loss equation does not. While controlling weeds with a programmed series of applications of three herbicides may be novel and offer a labor saving alternative, this approach may not be appropriate where farmers are seeking new methods that are familiar in terms of their past experiences with weed control by mechanical means.

Uncertainty about results of a proposed practice may stimulate thought and discussion, but we know that risk-averse small farmers will be concerned about the relationships between success and a new practice. Although dissonant messages may help maintain interest in a presentation, farmers are seeking relevant production practices that are easily understood and applied in their own farm context. In this same vein, completely aversive approaches can be stimulating but run the risk of alienating an audience, and there should be greater probability of adoption of practices that are intrinsically satisfying to the farmer group. It is important to maintain a clear focus on meaning throughout presentations, and this can be achieved through appropriate message design.

Order. Order is an important audience requirement because people generally prefer predictable learning situations. They look for patterns and regularities. Providing order through message design can be done in several ways. First, the product approach describes and directly presents the content, "to effectively control cutworm in maize, apply this granular insecticide at planting time."

A second approach is the use of process (Francis et al., 1987). This route guides the audience to discover answers for themselves. "There is potential for cutworm in this planting of maize; what are the options for control or management? We could scout the previous year, rotate crops, plant a resistant variety, change to another crop, wait and see if there is a problem and then apply an insecticide, or intercrop the maize with

beans and squash to reduce the incidence of cutworm. What are the probabilities of success of each approach, the immediate economic costs and the effects on the environment?" Thus the audience needs to evaluate a series of options and consider their costs and consequences.

Order can also be made easier for adult learners by "chunking information." A total message can be broken into smaller units that will be more comprehensible and better remembered—with examples presented as part of the message at each stage. Messages and data can be chunked in a chronological, hierarchical or procedural manner. Relationships between ideas are suggested by grouping similar or perhaps dissimilar materials. Comparisons and contrasts are also effective ways to denote relationships.

A variety of presentation techniques allows information to be repeated in different ways. This means that information can be reiterated at different levels of abstraction and elaboration, perhaps reaching different members of an audience in this way. Extension messages can start with the more concrete and simple information (e.g. rotations of cereals with legumes can provide nitrogen for the cropping sequence as well as control some weeds and insects) and progress to more speculative and abstract (e.g. legumes fix nitrogen from the air through associative bacteria, and pests are controlled by breaking their life cycles in a rotation). The abstract discussions should be used with caution, however, as too much emphasis here could result in loss of stimulation for much of the audience.

Strategy. Extension audiences and others want and need a learning strategy. This includes guidance and feedback in selecting, processing and using information. Written or visual messages can be designed using headlines, titles, statements of objectives and topic sentences. These methods facilitate the audience's attention and perceptual processes. Elaborating on each subject helps to promote the retention of data. Using relevant examples to illustrate each case and using cues during a presentation guide learners in forming and internalizing concepts. Active participation encourages people's long-term memory to store messages. Design of a presentation, whether visual or written, needs to include time for the audience to reflect, integrate and apply the new concepts to their own real life context of farming.

These techniques-stimulation, order, meaning, strategy—can be used to better design messages for our audiences and stimulate their serious consideration of new and more sustainable agricultural practices. Specific techniques address the cognitive processes that take place during learning. At the same time, there are many other techniques that can be used:

1) using introductions and final summaries to help organize thoughts;
2) relating messages to prior knowledge;
3) emphasizing relevance and utility;
4) providing feedback and reinforcement; and
5) keeping the audience aware of goals.

These are all part of message design.

Using the techniques associated with stimulation, order, meaning and strategy, FSR/E specialists can develop messages and programs to better communicate messages and data. The audience is more likely to remain motivated, active and involved in the learning process. The final result is an audience that will learn more. This can lead to more rational decision making as we consider options for a more sustainable agriculture in the future.

LOOKING AT COMMUNICATION

Rank (1976) presented two ways to analyze communication. We can apply these patterns to studying message design. He first suggested that all messages are intensified at various times. Data and messages are repeated, associated and composed and arranged in certain ways to shape our behaviors—to influence us. At other times messages are downplayed. Certain data are omitted or they are diverted. Messages can also be confused. First, let us look at how messages are intensified and then at how they are downplayed.

Intensifying Communication

Data and messages can be intensified, strengthened or highlighted. This is done three ways.

Repetition. This is an easy, simple and effective way of intensifying messages. People are comfortable with the familiar and the known. Repetition impacts on our memories so we will identify, recognize and respond to certain data. Repeated reference to a specific brand of maize hybrid on TV is an example. Producers should look for and question messages about uniqueness and the amount of benefit to themselves.

Association. Messages are associated by linking them to something already used, liked, desired or disliked by people. We associate data and messages by direct assertion or by indirect ways-allusions, background, context. The successful farmer standing in a weed-free soybean field while advertising herbicides demonstrates this tactic. Testimonials, group pride, heritage and progress are other methods of association. Producers should be wary of demonstrations featuring people "like themselves." They should look for cues and prompts indicating relationships.

Composition. Messages can be patterned and arranged and thus intensified. Messages are purposefully designed; variation in sequences and proportion are developed. The choice of words, the level of abstraction, the music, the particular visuals and the selection of certain data are all part of message intensification by composition. An ad stressing grandchildren, pictures and home environment is really a pesticide sales approach. Producers need to take time to study the structure of the data and message-order in which it is presented.

Downplaying Communication

Messages and data are reduced or made subtle with omission, diversion and confusion.

Omission. This is a common method since the process of selecting data and messages probably suggests that some of them are necessarily left out. Too much data can create confusion; therefore, some of it is often omitted. However, omission can be used to conceal or muddle certain data. Maize companies select data to include in their yearly fact books. Producers need to ask questions to fill in gaps in relation to their own farming saturations and to future cropping practices.

Diversion. Data are diverted by distracting focus or attention away from key issues or important messages. Humor and entertainment are pleasant ways to divert attention. One pesticide advertisement has an elephant standing in the field. Emotional name calling (nit-picking or hairsplitting) are also common diversionary techniques. We see much of this in the current national political campaign. Producers must continue to question information and not be put off by diversionary techniques.

Confusion. Sometimes data are so complex or chaotic that people give up, get weary or become overloaded; they do not take time to find their own meaning in the message. Confusion results from illogical messages, contradiction, multiple diversions, inconsistencies or jargon. Anything that blurs clarity or understanding adds to confusion. This would be a superb introduction to sale of a specific "product" to help the farmer avoid this confusion. Producers need to step back from the data and compare their meaning with their neighbors', with past experiences, with present performance and with desired future performance. They need to be sure what prerequisite inputs or skills are necessary.

THE NEED FOR MULTIPLE DATABASES AND COMMUNICATION STRUCTURE

The complexity of problems faced by farmers today and the multiplicity of message sources require that we dedicate substantial thinking and resources to organizing and networking communication efforts. There is a need to provide easy access to sources, to make this system user friendly and economically accessible to a wide range of farmers and groups. There is a growing information base, yet this often becomes inaccessible because it belongs to different agencies or departments. An essential part of the future information system includes an efficient interfacing and accessing among these sources.

Even more critical is the exchange of data between supplier and user, to the point that everyone in a network is both client and resource person. When there is feedback into a network from each person who has a quantifiable experience with a cropping practice recommendation or new genetic variety, the database is expanded in a rapid and useful way. Obviously there is a need to screen the inputs into this system and to place some type of "quality control" on data infusion into a system. Yet this is one way to greatly expand our information base and to assure that all participants feel ownership of the system and the process.

The hardware exists to provide this type of interface, this type of interaction and continuous updating of the database and the efficient functioning of the system. There is a long way to go both on the farm and in our public institutions to encourage and catalyze the use of this type of information network.

We need more than hardware. There is a need to sort what is useful from the "noise" in the system. We need to provide mechanisms to localize information in order to make it most relevant for each audience-or to allow the user to define the range of experiences/information that is desired within a total database. And the system needs to be both affordable and friendly to the user. These are not challenges to be taken lightly-and the public sector has an invaluable role to play in the implementation of such an information/communication system.

HOW DO WE IMPROVE THE COMMUNICATION ENVIRONMENT?

Earlier we noted the need for multiple databases and an adequate communication structure. We need the databases for the design and development of messages; we need the communication structure for the organization and management of the delivery systems.

Tied together, these configurations will provide for an essential communication environment. To realize that aspiration, we need to address some select objectives (Butler, 1983). Lionberger (1986) previously noted some cautionary concerns at the 1986 Farming Systems Research and Extension Symposium. Vigano (1985) also brought up comparable suggestions in his study of a Honduran water and sanitation project. Ray (1987) discussed some of the components of the following objectives, as did Claar (1988).

Data and Message Needs of Our Varying Audiences

As our audiences have agricultural and development needs, they also have communication demands. We must identify target audiences for our project. The current effort of the Communications Subcommittee of ESCOP to promote and improve communications and planning between State Agricultural Experiment Station administrators and communicators provides an excellent and handy technique for doing such an analysis.

This means linking our audiences to our goals and objectives. This means spotting the areas of "uncertainty" where our data and message can make an impact. Where and to whom should we provide awareness data and messages; where and to whom should we underscore attitude messages; and where and to whom should we accentuate action messages?

Determining the needs of the individuals involved is a basic premise of FSR/E and ought to be part of the communication system.

Communication Barriers

Where systems interface and where boundaries exist, there are communication barriers. FSR/E projects must determine the communication barriers our target audiences experience. We can then better choose communication strategies to overcome literacy problems, distance concerns and accessibility. Communication cannot solve all problems, and it is not the recommended solution to all problems. When communication strategies are a recognized and integral component of the overall development effort, they will be more successful than when we leave them to chance.

Documentary and Statistical Databases

Just as we collect data from on-farm experiments, we need to develop and collect communication-related data. We should build these collections into multiple access databases. FAO, USDA and others should take the lead in either developing or funding such efforts. Credit should go to groups developing the beginning of a worldwide agricultural database, such as the University of Florida, Winrock International, Kansas State University, the University of Illinois, the Clearing House for Educational Development Communication and the Academy for Educational Development, as well as the International Agricultural Research Centers and other projects (such as the NifTAL Project, University of Hawaii). These databases can be expanded and networked, and they would be welcomed.

Message Products

We need to seriously examine the actual messages we send. How are they designed, how effective are they, was the target audience exposed to them, did the message cause any change in awareness, attitudes or behaviors? Pre-testing of messages, translation checks, focused group interviews and other FSR/E evaluation and research techniques can be used (King, 1983, 1984 a, b; Massoud, 1988; Rana, 1987).

Adequacy of the Communication System

Full blown examination of the communication systems, with audits and evaluation, would provide needed data. Case study methodology (King, 1984b) along with other qualitative and quantitative procedures could be used. Proficiency of communication is a necessary element of our FSR/E programs. For subsequent undertakings, determination of the competency of communication systems is imperative.

We expect our communication efforts to prosper. Attending to these issues will foster competency based on the development of credible and reliable databases linked to manageable communication systems.

CONCLUSIONS

This entire discussion hinges on one as-of-yet-undiscussed concept--responsibility. This involves responsibility of institutions, professional communicators and clients. If we are to design FSR/S projects, if we are to work in on-farm situations, if we are to involve our audiences, then we must all assume responsibility for good communication. That communication must be credible, manageable and timely. Our communication systems must also provide for two-way linking mechanisms. Feedback in communication systems has to be built in. Real audience participation will make the difference between success and one more mediocre program or publication.

Our title, "Back to the Future: The Power of Communication and Information," is now less relevant. With these messages and with the data we have to communicate, the next discussion could be titled, "Back to the Future: Communication and Information. . . as Power."

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CONTRIBUTIONS OF FSR/E TOWARDS SUSTAINABLE AGRICULTURE

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INTRODUCTION

In most tropical regions, farmers are confronted with the urgent need to adapt their farming system to the changing circumstances under which they have to produce. Technological and institutional change is necessary to cope with population growth, decreasing soil fertility, changing climates, markets, prices, demands and needs.

Formal research and development (R&D), based on the Transfer of Technology (TT) model, provides new technology. Yet this approach has not addressed the need for the creation of sustainable agricultural systems or provided technologies for "low resource" areas. It also has not been able to contribute to a substantial increase in the production levels.

R&D workers are now experimenting with approaches to technology development in which farmers play an active role. These approaches range from participation of farmers in formal R&D programs and support for farmers' experimentation to activities to strengthen farmers' capacity for technology development.

This paper reviews the role of farmers and other experts in the development of technology. It assesses the impact of the present TT model in different agricultural systems and argues that there is a need for a new practice in technology development. That practice should integrate the complementary domains of indigenous technical knowledge and formal knowledge. The article refers to a great number of experiences with this practice, formulates questions to be answered and indicates a direction on how to continue. The implications for institutions for agricultural research and extension are elaborated.

Recommendations are made to develop the existing programs for FSR/E by giving a reorientation in the following two directions: the focus of research and development activities (i.e. putting more emphasis on local resources, diversity in prevailing ecosystems, the use of its linkages and the cyclic character of agriculture) and the approach of research and development activities (i.e. the use of methods that use local knowledge and skills to strengthen farmers capacity to develop technology).

FARMERS AS DEVELOPERS OF TECHNOLOGY

Since the earliest stages of agriculture, farmers have been active in developing technologies for the production, processing and storage of food. Farmers discovered, selected and domesticated all of the major food crops and animals. Farmers have developed their knowledge through processes of learning, experimenting, observing, teaching and communication. The existing farmers' knowledge at a certain time and place is the accumulated result of these processes.

Farmers' knowledge is the result of social experience and is location specific in response of population pressures and environmental conditions. Agricultural practices have emerged as a result of adaptation to and manipulation of the physical environment. In this way, a great variety of farming systems has developed. In these systems, the ways in which the factors of land, capital, labor and knowledge are combined are very much determined by the specific physical and social conditions that prevail in the area.

Farmers continue to play a very important role in technology development. This capacity of farmers has never been well acknowledged by agronomists. There are relatively few publications on farmer-originated technologies and systems (Rhoades and Bebbington, 1988), and an impression has been formed that farmers are merely agricultural producers who depend on the external agencies such as research, extension and commercial enterprises for innovations. However, farmers have remained active in the process of technology development rather than being simply "clients" of "change agents" (Richards, 1979, 1985; Rhoades 1982, 1987 Chambers 1985, 1988; Box, 1986; Brokensha et. al., 1980).

Rhoades and Bebbington (1988) provide evidence that there is a farmer-based method for research, which in many ways is similar to the scientific method. He cites examples of farmer-generated innovations and farmers adaptations of external innovations that follow the steps of formulation of a problem, formulation of a testable hypothesis, testing the hypothesis empirically and validating or invalidating the hypothesis.

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RESEARCH AND EXTENSION AS DEVELOPERS OF TECHNOLOGY

The position of Rhoades and Bebbington deviates from "diffusion of innovations" or TT model, which holds the assumption that there is a large stock of sound scientific information and technology ready to be transferred from researchers to farmers. In this view, it is the farmers' characteristics such as class, age, schooling, attitude, etc, that determine the rates of adoption rather than the inherent quality of the technology or the access of the farmers to inputs required. This approach generally has neglected ecological and environmental factors and assumes that the technology introduced to the farmers will be in the same form as the technology ultimately adopted by them.

Until recently, even methods used in Farming Systems Research (FSR) and the Training and Visit System (T&V) of extension are based on the assumptions of the "diffusion of innovations" or TT model However, FSR evolved as a response to the need to identify opportunities for appropriate technology changes among poor farmers.

FSR is characterized by Farrington and Martin (1987) as an applied problem-solving approach conducted by multidisciplinary teams with a degree of farmer participation in which the perspectives of technology change are assessed within a holistic framework. It identifies homogeneous groups of farmers within specific agroclimatic zones as the clients of research. In the FSR approach, on-farm trials are carried out, and the results of one year's trials generate hypotheses for testing in the next and should influence on-station research priorities.

Although FSR originally was supported with much enthusiasm, criticisms have arisen. These include the following:

- The institutional conditions needed to make FSR really work have not been created;
- A major thrust has been the implementation of large, expatriate-led FSR programs; local scientists and local institutional networks have hardly been involved yet;
- Multidisciplinary research proved problematic, and the focus on the holistic approach has led to the collection of unwieldy volumes of data;
- FSR is still dominated by the TT approach, does not focus on the problems and potentials of the resource-poor farmers or seek to find unconventional technological alternatives taking into account the complexity and diversity of prevailing agricultural systems;
- The present researchers have been insufficiently trained to communicate with, learn from or cooperate with farmers.

THE IMPACT OF TRANSFER-OF-TECHNOLOGY IN DIFFERENT AGRICULTURAL SYSTEMS

The TT approach has been the basis of the industrial agriculture in western countries and the green revolution agriculture in developing countries. In both cases, the conditions are such that relatively uniform practices requiring high external inputs have been adopted. These adoptions have led to agricultural production that exceeds the level of sustainable production. In the western agricultural systems, there is a clear tendency to reduce the levels of external inputs.

The impact of the TT approach in most of the rainfed, tropical, low-resource areas has been very limited. These areas are found in the hinterlands of the Third World, including most of sub-Saharan Africa. Probably between 1 and 1.4 billion people rely on them directly for their livelihoods. Farming systems are generally complex, the environments diverse and the production prone to risks. Land tenure is often insecure. The potential of these agricultural systems is regarded as low by conventional agricultural scientists. Agricultural technology as it is being developed by agricultural scientists and introduced by governments and private agencies to farmers in developing countries is biased by its western origin. The investments as a percentage of the gross value of agricultural products made for agricultural research and extension in western agriculture are 3-4 times higher than in the developing countries (Evanson, 1986). The biased perceptions among researchers and policy makers of the agricultural situation in the developing countries leads to inappropriate technology, inappropriate assessment of the development potential of certain areas and, consequently, inappropriate development investments. Labor-saving effects, the effects on gender relations and the position of women, the ecological effects and the socio-economic effects of many technological developments are frequently harmful and lead to increasing economic and political dependency of developing countries (Haverkort, 1988). The challenge for those who are involved in technology development and transfer is to develop creative alternatives.

Modern agricultural technology requires a certain infrastructure for supply and maintenance of external inputs and services, assumes capital investments at farm level and needs a stable environment. Little basic or applied research has been carried out to improve the productivity of crops and animals that are unknown in the west. For example, research on water buffaloes or the use of other domesticated or wild animals and research on local food crops such as cassava, sweet potatoes, sorghum, millet and most tropical trees and fruits is very limited as compared with their importance in the national agricultural production process.

Concern for sustainability of the green revolution agriculture is expressed by many policy bodies, such as the World Commission on Environment and Development in its publication *Our Common Future* and the Technical Advisory Committee of the Consultative Group for International Agricultural Research (CGIAR) in its report *Sustainable Agricultural Production; Implications for International Agricultural Research.* Efforts are now being made to reorient the processes of agricultural technology development in such a way that sustainability and stability of the systems receive more priorities.

PRODUCTION POTENTIALS

The TAC/CGIAR report makes a distinction between "open systems," where industrial inputs are used abundantly, and "closed systems," or systems where few external inputs are used and that produce little more than the subsistence needs. The report assumes that the indigenous farm population has learned to manage closed systems efficiently, making it difficult to increase their production without resorting to external inputs. If increases are possible, their rates are insufficient to meet the demands for food of the growing population. In contrast, "open" agricultural systems may produce considerably more than the requirements of subsistence. However, these open systems require more external inputs, which can be harmful to the environment and need fossil energy for their production, maintenance and use. The report makes an important assumption that it would not be possible to meet the food demands of the increasing world population unless more, but less suitable, land were brought into cultivation, further degrading the surface of the earth.

There are good reasons to argue that an analysis based on the distinction between the open and closed systems has limitations not only because closed systems hardly exist, but especially since it reduces the problem of agricultural development to the degree to which they use external inputs and thus leaves aside the discussion on questions such as the following:

1. How can the use of local resources be optimized?
2. How can local resources best be complemented with external inputs?

This approach is based on the assumption that, although the local population has learned to manage these systems efficiently, there is the need and the possibility to adapt the traditional management systems. In rapidly changing environments such as occur when shifting cultivation systems are breaking down, many facets of farmer knowledge are not adopted anymore and must be interpreted as vestiges of former cropping systems that are now obsolete (Fresco, 1986).

The possibilities to make agriculture more efficient are to be found not by resorting to imported inputs, but by optimizing the use of indigenous resources, making use of indigenous knowledge, the farmers' own capacity to develop technologies, by comparing resource use in similar ecosystems and by looking for production potentials in an unconventional way, such as crop/livestock diversification.

The creativity of farmers and researchers in areas where external inputs are not available, where the prices of the inputs are too high to justify their use or where the ecological effects have been too heavy has led to a number of practices that could be categorized under the heading of "Low External Input Agriculture" (LEIA). Note that this type of agriculture does not exclude external inputs but rather seeks to exploit the locally available resources by the application of scientific insights. The overall intensity of input use may eventually be very high.

Recent reassessment of the production potentials of tropical areas on the basis of their locally available resources and local experiment capacity (Haverkort, 1988) indicates that major increments to sustainable output are possible.

SOME EXAMPLES OF LEIA PRACTICES

Agroforestry

The role of trees within agricultural systems has long been misunderstood. Presently the role of trees is considered important for erosion control and the production of firewood, fencing and construction material, herbs, staple and relish foods, fruit and fodder. Trees can improve micro climates and soil fertility as well as offering important cash incomes for rural populations. New methods (Bradley et al, 1985) are being developed for the integration of trees into agricultural production systems by different projects such as the Kenyan Fuelwood Development Program. Research carried out by IITA gave impetus to systems such as alley cropping, where trees planted in rows are combined with production of crops. Research revealed more than doubling of yields of maize when mulching with *Leucena* branches took place. *Acacia albida* growing in the sorghum and millet fields in the semiarid areas in Africa reportedly increased the yields by 50 to 100% and at the same time increased the protein production of these grain crops by 60 to 250% (Sturmheit, 1988).

Soil and Water Management

Methods of maintaining, improving and even reclaiming soil fertility, techniques for small-scale irrigation, water harvesting and communal water management are now increasingly attracting the attention of researchers and development workers. In Burkina Faso important achievements have been made in reclaiming soil in the Sahel area by the construction of filtering dams and/or by planting rows of *Andrapogon* hedges, which are modifications of the traditional techniques of soil conservation. Villages that were suffering from soil losses and (subsequent) emigration now have reclaimed considerable areas that are fit for intensive cultivation (Haverkort, 1988). Similar experiences have been reported from India and Fiji, where a combination of contour plowing and planting (for in situ moisture conservation) with *Vetiver* grass barriers led to increase of yields of 50 to 200% without substantial increase in costs (Greenfield, 1988).

Recycling of crop and animal residues and green manuring can reduce losses of nature resources at the farm level. Losses occur through erosion, leaching and exportation of produce to marketing channels. Applications of nitrogen-fixing micro-organisms (e.g. *Rhizohia* bacteria in legumes and *Azolla*, a water fern capable of utilizing atmospheric nitrogen in symbiosis with the blue-green *alga Anabena azollae)*, use of farm yard manure, byproducts and household refuse for composting and mulching are techniques that can be adapted to specific ecosystems.

Rice - Fish Culture

MacKay et al. (1986) report a spontaneous development of the introduction of fish (Tilapia, common carp and *Puntus* spp.) to rice paddies in Thailand and pesticide use and increased incomes.

Multiple Cropping Practices

Intercropping refers to the practice of growing different crops at the same time. Research has shown that under certain conditions, the total production of intercropped fields can be higher than in cases in which the crops are grown in pure stands. Intercropping can have labor-saving effects (e.g. weeding) and may reduce pests, diseases and risks.

Selecting and Breeding

Local plant and animal varieties are generally adapted to the specific conditions prevailing in tropical non-irrigated areas. Plants that are tolerant to drought, acidity, toxicity and micro element deficiencies as well as animals that are resistant to diseases and are adapted to the fodder base in the area are crucial for agricultural development. Farmers in the Sahel are using seeds of sorghum and millet with a wide mix of varieties as a mechanism for risk minimization. Farmers' knowledge of the characteristics of the local seed varieties and their criteria for good seed are essential input for seed improvement programs (Linneman and de Bruyn, 1987).

Crop-Livestock Polyculture

The green revolution has led to a neglect of livestock production and to the underrating of livestock in agriculture. At present animal traction and integrated crop and livestock production are receiving more attention. Examples are the interactions between herders and cropping populations (i.e. crop residue grazing-manuring, trading of grain with meat/milk), the development of fodder banks (Waters-Bayer and Bayer, 1987) and feeding tree byproducts to livestock (FAO, 1983). Animal and crop wastes are recycled to generate biogas, feed for ducks and fish and fertilizers (Essers 1987; Waters-Bayer and Bayer, 1987).

Integrated Pest Management

This method emphasizes using resistant varieties, conserving natural predators and cultural practices that minimize the risks for infestations (Gips, 1987; Maralet, 1985). In 1986 Integrated Pest Management was declared the national pest control strategy for rice in Indonesia. The results after 18 months are that the number of insecticide applications have dropped from an average of 4.5 applications per season in 1986 to an average of 0.5 applications in 1988. As a result, the cost for insecticide for farmers has fallen to one-third of the original level and the cost for the government subsidy has decreased even more, whereas the average rice yields have increased from 6.1 tons to 7.4 tons/ha. Intensive training and extension programs were launched. The powerful positive response of the farmers surprised local officials; farmers were happy to save money and manage their crops with deeper ecological understanding (FAO, 1988).

Microclimate Management

Temperature, wind velocity, soil structure, relative humidity and light intensity are factors that influence plant growth and production. Careful management of these aspects are often within reach of farmers, and possibilities may exist to improve the knowledge farmers already have with scientific knowledge (Stigter, 1986; Balasubramainam, 1987).

Diversified Crop Production

It is common to find distinct soil types linked together in a regular sequence from valley floor to hill crest. Typically, the sequence might comprise a free-draining gravelly soil on the hill crest and valley sides, a silty river-terrace soil further down slope and a water-logged valley-bottom soil. Many small farmers have designed cultivation and planting strategies to get the best out of the topographical sequence. In particular, matching crops to the different soil conditions is a way of coping with two major hazards: rainfall irregularities and seasonal labor shortages. In Sierra Leone farmers generally use one or two quick-yielding varieties for intercropping on upper slopes, two or three medium-duration varieties for intercropping on upper slopes and one or two flood-tolerant varieties capable of growing in valley swamps (Richards, 1985). This risk-spreading strategy of farmers frequently exploits ecological diversity. Extension and research need to be designed to harmonize rather than compete with these strategies (Altieri, 1987).

COMMON ELEMENTS IN LEIA PRACTICES

The practices mentioned above have in common that they are based on one or more of the following principles:

1. They use the prevailing diversity in the ecosystem and exploit the linkages and combinations of diverse components for creating sustainable and stable production.
2. They use an integrated approach by taking into account the total effects of the processes on production as well as on the environment, thus looking upon agriculture as a cyclic process.
3. They seek solutions for production and sustainability by considering unconventional and local resources.
4. They link in with the local knowledge systems and existing farming practices and strengthen farmers' capacity to develop technology.

In understanding, managing and exploiting the internal linkages of the components of undervalued resource farming systems, farm families have a comparative advantage. They are the experts. They generally are better equipped to try out varieties or practices and fit them to their whole farming system.

This implies that the process of technology development that has had such an impact in the industrial and green revolution agriculture needs to be modified substantially. LEIA does intervene in the natural ecosystems (Table 1) by the application of scientific insights, but the principles as well as the impact of the intervention are different from those of high external input agriculture.

THE NEED FOR A NEW APPROACH TO TECHNOLOGY DEVELOPMENT

The challenge for farmers, researchers, extension workers, traders and industrialists will be to adopt an approach to technology development that overcomes the bottlenecks of sustainability and that will lead to an increase in productivity. The term *Participative Technology Development* (PTD) describes the process in which different partners work together in the effort to improve the technology being used. It is the practical process of bringing together the knowledge and research capacities of the local farming communities with that of the commercial and scientific institutions in an interactive way. PTD involves activities in which local producers and traders work together with external actors in the identification, generation, testing and application of new technologies and practices. PTD, therefore, seeks to strengthen the existing experimental capacity of farmers and will sustain on-going local management in the processes of innovation.

Participation

One of the key issues in this process is farmer participation. McCall (1987) distinguishes three levels of participation:

- as a means to facilitate the implementation of external interventions;
- as a means to mediate in the decision making and policy formulation of external interventions;
- as an end in itself, the empowerment of social groups towards access and control over resources and decision making.

In practice, participation is often only used as means to legitimize top-down approaches. McCall states that local participation in the past meant that local people were expected to provide physical labor as their contribution to projects, the outsiders' contribution being not only finance, but the whole design and planning of the project. Since then participation has come to mean that local people also assess their own needs and priorities.

In PTD, participation implies an acceptance that people can, to a large extent, identify and modify their own solutions to their needs; it means that researchers and development workers need to support farmers to increase their capacity to manage changes in their farming systems.

Obstacles to Participation

In promoting participation there are several obstacles to overcome.

- Local government agencies and bureaucratic forces, despite their rhetoric of support, have reasons to fear local participation and may contain the threat by diversion or incorporation. Prejudices exist among professional agronomists and development workers against the assumption that the rural population may have something to contribute.
- Women face special obstacles. Heavy labor inputs prevent them from taking part in meetings. Cultural restrictions prevail against appearing or speaking at open meetings. There are also socio-psychologically inflicted senses of the inferiority of women's work and interests. The majority of development workers and state personnel communicating with the villagers are men, and most traditional societies have a patriarchal culture, reinforced by the colonial and post-colonial ideologies of the peasant household.
- In most countries, resistances to certain rural minorities exist, based on race, tribe or religion. Thus, participation in local-level development initiatives by rural minorities is resisted by the dominant groups.
- The poverty of certain categories means a lack of access to, or absolute scarcity of, resources and lack of hope of any improvement. Thus, risk-aversion strategies have to be taken into account.

Professionals engaged in agricultural technology development will need a lot of creativity and endurance to identify and overcome the obstacles. This requires not only agronomic qualifications, but also special social skills and anthropological or sociological techniques. There will be no specific guidelines for overcoming these obstacles. The diversity of the phenomena requires diversity of solutions.

Indigenous Knowledge

The experiences with technology development have made clear that new technologies have to be imbedded in the local society, its physical environment, its cultural experience and its socio-economic structures. For people who have not grown up in the local society, it is very difficult to understand the whole livelihood system

in all the complexities of physical, socio-economic and cultural interrelations in its historical context. In the process of technology development, knowledge of the indigenous livelihood system is an indispensable resource that is possessed and can be managed by the local community. Indigenous knowledge (IK) is not abstract like scientific knowledge; it is concrete and relies strongly on intuition, historical experience and directly perceivable evidence (Farrington and Martin, 1987). IK reflects the dignity of the local community and puts them on equal footing with the outsiders involved in the process of technology development. In this way IK is the key to participation and the confidence needed to counter the fatalism of poverty (McCall, 1987).

EXPERIENCES WITH PARTICIPATIVE TECHNOLOGY DEVELOPMENT

ILEIA has documented some 200 case studies and articles with practical descriptions of field experiences. The experiences have been documented according to five categories of activities in participative technology development:

1. How to get started:
- How to build up a relationship of confidence aimed at cooperation with local networks of farmers and other actors.
- How to make a joint analysis of the existing situation, farming systems and problems.
2. Looking for things to try:
- The identification of indigenous technical knowledge and relevant formal knowledge.
- Screening and selecting topics for further development, using criteria leading to optimal use of local resources and sustainable production systems.
3. Trying out:
- Developing the joint capacity in experimenting.
- Planning and designing experiments, implementing them and evaluating the results.
4. Sharing results with others:
- Communication of results with other local and scientific networks to scrutinize and interpret them and to incite others to adapt and test the results for their circumstances.
5. Sustaining and consolidating the system of Participative Technology Development:
- Creating favorable conditions for farmers organizations, local institutions and support at policy level
- Establishing physical infrastructure and educational facilities to strengthen local experiment capacity and local management of the processes of innovation.

The descriptions range from scientist-dominated research to support of farmer technology development entirely based on local initiatives and oriented towards the needs and possibilities of the farmers. In practice, a linear step-wise sequence of steps taken does not occur. Instead there are iterations, laps and overlaps.

IMPORTANT QUESTIONS TO BE ANSWERED

1. To what extent can PTD make the development of technology more cost effective? Most of the cases reported so far implied a high labor input. When the approaches are further developed, the labor input required may be reduced.
2. How can PTD be institutionalized? Most cases reported are project based, and a good deal of them are carried out by non-governmental organizations. How can the official national agricultural research systems be encouraged to apply PTD? What shall be the role of the agricultural extension services? Is the present institutional differentiation of tasks between researchers and extension workers beneficial or detrimental for the application of PTD?
3. How can sustainability be built in as an important aim of PTD? The use of local resources as such does not necessarily lead to sustainable agricultural systems. The approach offers some perspectives, but additional conditions have to be formulated, and additional insights need to be developed.
4. How can agricultural education and training be reformed in such a way that the new generation of technicians will be able to communicate with farmers and understand their complex systems?

WHERE TO GO FROM HERE

In conclusion, it is advocated that a change be made in emphasis of agricultural research and development away from a predominant development of single commodities or specific "stand-alone" techniques towards the development of a more broadly based package of technology that relies on local resources and use of linkages between components of a diversified system. In these practices of Research and Development, the complementarity of scientific knowledge and local knowledge can be optimized.

A change in emphasis does by no means imply a suggestion that present fundamental and on-station research should be abandoned. They should continue to play their role. Probably they will get encouragement to start research on topics that come to light in the LEIA approach. Fundamental questions related to factors explaining competition, symbiosis and synergy need research of a type that cannot be carried out at field level alone.

Research and extension, therefore, need to adopt a different set of values (Chambers, 1988):

- A philosophy of decentralization, diversity and choice. This emphasizes the primacy of what people need, want and can achieve in their environment. It stresses the importance of diversity and aims to manage diversity through decentralization and local initiatives.
- A new role for outsiders. The outsiders as development workers should abandon the role of the missionary who transfers exogenous technology and should rather adopt the role of convener, catalyst, colleague and consultant. The outsider convenes discussions and analysis by farm families and speeds up reactions. He or she is a colleague of farmers in their experiments and acts as a consultant who can search for and supply ideas and technologies unknown in the rural community.
- A wider repertoire. What is needed is not a new fixed model, equivalent in structure to the transfer-of-technology with rigidly related parts, but rather a fluid process in which the development worker is a performer who improvises and adapts for each situation. Just as diversity of environment and farming system is recognized as positive, so diversity of repertoire in interaction with farm families is seen as necessary and beneficial.

These changes may imply that existing entities for research and extension at international, national, regional and local levels should ask questions on the justification of their existence and the relevancy of their programs and staffing policies and on that basis reflect on possibilities to adjust and change in a new direction. History determined to a large extent the existence and functioning of Research and Extension agencies, but the present activities and output will determine their future.

The following recommendations are therefore proposed for consideration.

1. Make case descriptions of successful interventions based on Low External Inputs and analyze the principles explaining the success. Improve and elaborate the principles as described above on the basis of accumulating experiments.
2. Formulate research programs on fundamental questions related to LEIA and study the question whether the existing entities and organizational structures are the most appropriate to carry out this type of research.
3. Organize seminars to exchange experience on LEIA and to develop and discuss the principles.
4. Form networks of researchers and field staff working on LEIA to provide mutual support and encourage the development of the approaches.
5. Establish and develop operational field approaches for participative technology development.
6. Carry out in-service and on-the-job training for field, staff researchers and development workers. Develop curricula on the principles and technicalities of LEIA and PTD. Produce manuals and training modules; short, practical and user-friendly manuals are needed to guide trainers and field workers. Train trainers. Successful development workers should be used as trainers. They are there but may need training in training methods.
7. Stepwise adjust or re-organize existing institutions for research and development to allow activities in the domain of LEIA and PTD.
8. Monitor and evaluate new experiences and develop the most cost-effective methods and approaches.

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Table 1. Principles and impact of interventions.

	Agronomic intervention	
Principle	High external inputs	Low external inputs
INPUT USE	high external	high local
Level and origin	tow local	low external
Use of generic resources	hybrids	improved mixes of local varieties
Fertilizer predominantly	chemical complemented with organic	organic complemented with chemical
ROLE OF FARMER	client of technology development agencies	active in the development of technology together with agencies
Place of traditions and culture	replaced by modern concepts and values	integrated and developed
Use of indigenous knowledge	substituted by scientific knowledge	complemented with scientific knowledge
SCIENTIFIC KNOWLEDGE USED	reductionists and disciplinary approach	holistic and generalist approach
Impact of interventions	High external inputs	low external inputs
Effects on environment	externalized	integrated and accounted
Trends	Specialization incorporation	diversification autonomy
Potential production per commodity	high	moderate to high
Potential total productivity	moderate to high	high
Sustainability	low	high

COMMUNICATING PROJECT RESULTS: A MODEL FROM THE SMALL RUMINANT CRSP

Constance M. McCorkle, Donald L. Esslinger and June L. DeWeese[1]

PROBLEMS AND PRINCIPLES IN PROJECT REPORTING

FSR/E and related projects[2] devote enormous energy and sums to research and development but typically provide little planning, personnel or budget for systematically and effectively reporting and disseminating results. Instead, "Communication is often looked upon as a peripheral activity, a sort of luxury that is nice to indulge in if you can afford it, but not something as important as agricultural research" (Fraser, 1985). Nothing could be further from the truth.

If results are not regularly reported and actively disseminated, they cannot be put to use-whether by peer scientists, by extensionists who apply such findings in practical agricultural production, by the designers and funders of agricultural research and development (R&D) or by policy makers. In short, without active communication of results, the point of mounting a project in the first place is vitiated. Worse still, more large, expensive projects may be initiated to address the same problems all over again. As Tam (1982) warns, without systematic and effective information transfer:

> We will witness a considerable waste of money, time and effort, especially in developing countries... running also an exponentially increasing risk of duplicating what has already been done, or not benefiting from already acquired experience or of "re-inventing the wheel." No one can afford such a risk since it is too costly.

Related observations are echoed by many others, who document still further, pervasive problems in communicating and disseminating research results from international agricultural R&D (ADC and IRRI, 1980; Byrnes, 1980; CDCP, 1987; Chambers, 1983; CIRDAP, 1983; Esslinger and McCorkle, 1986; Guitierrez Jimenez, 1964; Hutchcroft, 1985; Norman, 1987; Powers, 1964; Thorpe, 1986; Toomey, 1987). Utilizing Hutchcroft's (1985) distinction among information, presentation and distribution plus Berlo's (1960) SMCR (source/message/ channel/receiver) framework, these can be summarized as follows.

Information

All too often, information generated by agricultural research is never "presented" in any systematic way; i.e. data are collected but never analyzed, research is conducted but not reported. The overarching reason for this has already been cited-lack of project emphasis on communication and hence failure to allocate adequate time, money, materials, support staff and rewards for analysis and reporting. A consequence is low motivation among project participants to report on their work at all, or to report in useful and effective ways. This problem takes many forms.

- Host country (HC) researchers often face special constraints in professional training, language of reporting, bibliographic resources and experience with reporting stylistics and outlets.
- For many reasons (e.g. linguistic difficulties, translation costs, disciplinary, prestige) expatriate scientists are usually poorly motivated to publish in HC languages and outlets. HC researchers and governments frequently voice this very valid complaint-one that raises serious ethical concerns about making information available within its country of origin in a useable and accessible form.
- No matter what their nationality, field-based personnel generally do not report as they should. They are busy with the day-to-day logistic, administrative, interpersonal and other pressures of just keeping a project going under often difficult field conditions. But this is no excuse.

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[2] Throughout the text, "program" and "project" are used interchangeably in general discussion, but the distinction is maintained when referring to the Small Ruminant Collaborative Research Support *Program* and its nine *projects.*

- Because of the strains of bridging diverse disciplines, cultural backgrounds and authorship, truly integrated research reporting is rare, despite the avowedly interdisciplinary and cross-national nature of most FSR projects.
- Almost all development projects are lax in informing wider HC, policy and public audiences of findings and activities, despite the facts that the continued existence of agricultural R&D depends on such groups' support; policy makers influence a wide range of R&D activities, all the way from defining research priorities to applying the results; and ultimately, general publics generate the funds, and they influence the policy makers (after ADC and IRRI, 1980).
- Finally, communication between research and extension is notoriously poor.

Presentation

Even when project results are reported, they may not be presented in a form accessible or appropriate to important receiver groups. Accessibility includes such considerations as the national language and disciplinary jargon in which the information is presented, the cost of obtaining it and the networks through which it is distributed. Appropriateness concerns a multitude of factors impinging upon matching message content and channel to receivers—the fundamental principle of successful communication.

There is a vast literature on these subjects for communication generally. But the limited literature dealing specifically with reporting on FSR/E and similar projects concurs[3] on one point: the principal traditional channels (scientific meetings, professional journals and annual reports) are hardly appropriate to all receiver groups; nor are they sufficient even for effective scientist-to-scientist communication. Other techniques are needed to increase the flow and impact of FSR information both in and outside the scientific community.

Distribution

Just formulating and presenting the message-even with careful targeting of receivers and channels-is not enough. It must also be sent. As Chambers (1983) notes, researchers "are astonishingly unrigorous in the diffusion of their findings… Diffusion and impact are often left to take care of themselves." Unfortunately, they don't. And going to the trouble and expense of gathering information and presenting or "packaging" it is pointless if it is not also effectively disseminated.

THE SMALL RUMINANT CRSP

The Small Ruminant Collaborative Research Support Program (SR-CRSP) has consciously sought to grapple with such problems and needs. This article reviews the evolution of SR-CRSP reporting strategies and offers a model of these experiences that is instructive for other projects with similar aims. Diverse communication channels are exemplified,[4] and practical production and cost considerations are also discussed.

SR-CRSP Goals, Structure and Participants[5]

Initiated in 1978, the Small Ruminant CRSP is the oldest and largest of 12 innovative multidisciplinary agricultural research, education and development programs established under the US Congress' International Development and Food Assistance Act of 1975 and its Title XII amendment, the Famine Prevention and Freedom from Hunger Act (Lipner, 1988; McCorkle, forthcoming). The program's substantive focus is the production, distribution, storage, marketing and consumption of small ruminant (sheep, goats, llama and alpaca) products among smallholders and the poor in developing countries. The SR-CRSP's defining features and goals can be summarized as follows.

- Conducting research in a dually collaborative (interdisciplinary and crossnational) mode;
- Strengthening both US land-grant and collaborating HC institutions' ability to apply research results to food and nutrition problems;-

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[3] However, the overwhelming bulk of the literature on communication in agricultural development, and in FSR/E in particular, understandably focuses on transferring information among researchers, extensionists, farmers and sometimes private-sector suppliers and credit institutions. For recent studies and background references, sec Bemis et al, 1988; Lionberger, 1986; Noerem and Abbott, in press; Ray, 1985; Roling, 1988. In comparison, very little has been written on communicating research results among scientists and higher-level receiver groups such as donor agencies or general publics.

[4] Many examples are drawn from the Sociology Project and the SR-CRSP/Peru, merely because the present authors are more familiar with these efforts.

[5] For greater detail on program goals, structure and participants, see Blond, n.d.

- Providing advanced training for US and HC students and professionals;
- Making results available in a useful form to extension experts.

Twelve US land grant universities and one private research foundation have formally participated in the SR- CRSP (Fig. 1). The program is administered by its management entity (ME) at the University of California-Davis. The ME is advised by a Technical Committee of all US principal investigators plus HC representatives; a Board of Institutional Representatives (BIR), with one delegate from each US institution; and an External Evaluation Panel (EEP), a multidisciplinary group of eminent scientists representing various interests (e.g. FAO, the World Bank, USDA and others). Overseeing the SR-CRSP are USAID, BIFAD and BIFAD's JCARD. Ultimately, the program and related public agencies are responsible to the US citizenry via Congress and other groups such as commodity growers' associations.

As Fig. 1 indicates, the KSR-CRSP spans five HCs and includes nine disciplinary projects directed by one or more of the 13 US institutions. Projects may work in only a few of these HCs or, in the case of sociology, in all five. In each country, a local R&D institution serves as lead collaborating entity. However, cooperative research and training arrangements with multiple organizations are the norm. Illustrating from Peru, more than 30 organizations have collaborated with the SR-CRSP. Collaboration has been both long- and short-term, formal and informal, direct and indirect. Across the past decade in Peru alone, literally hundreds of individuals have participated in the SR-CRSP.

Participants in each country represent a wide professional spectrum: high-level administrative and/or ministry nationals and USAID officials; both HC and expatriate researchers and scholars who span BA, MS and PhD levels; a corresponding mix of HC and US students; and local interviewers with modest levels of education but a career commitment to rural development. Extension staff is also impacted by the program.

Communication Needs on the SR-CRSP

Program results must be communicated to all the foregoing groups, as well as to their counterparts in the global community of international agricultural development (Table 1). Messages directed to these varied receivers must be tailored to meet their specific information needs, according to their roles and interests in the SR-CRSP or in agricultural R&D generally. Moreover, these messages must be sent in the tongues and communicative modes that best "speak" to and are realistically accessible to each group. Like many development initiatives, however, when the SR-CRSP was first formed, relatively little planning, personnel or budget was explicitly provided for systematically and effectively presenting and distributing information about program activities.[6] As research progressed and results began to accumulate, the need for a broad yet consciously targeted communication plan became ever more evident. Such a plan clearly had to incorporate, motivate and provide professional development opportunities for the varying levels of participants; integrate diverse disciplines; accommodate many different receiver groups and national languages; and achieve all this in a cost-effective manner.

SR-CRSP COMMUNICATION STRATEGIES

Communication strategies can be examined from many different perspectives. We chose to look at major receiver groups and communicative intent—whether to inform, inspire (motivate, promote and persuade) or instruct (teach). Using these distinctions, SR-CRSP strategies for research reporting fall into five functional categories (Table 2).

Classification of a given communication (document, videotape, electronic transmission, etc.) is somewhat arbitrary since it can, and indeed should, address more than one receiver group and intent simultaneously, language permitting. The relevant languages can in turn be classed into three types.

- The program language (PL) is usually the national language of the funding agency and the tongue in which it requires regular, formal reporting-on the SR-CRSP, English.
- In much of the developing world, the dominant national language (NL) is a Western colonial tongue that has been designated an official language. This usually becomes the operating SR-CRSP language in-country-e.g. Spanish (Peru), Indonesian, English (Kenya) and Portuguese (Brazil).[7] Additional NLs

[6] In retrospect, the SR-CRSP's "relatively little" initial attention to these needs was in fact considerably more than many programs'.

[7] Morocco is something of an exception. French is the principal SR-CRSP operating language in-country, but Arabic is the only officially recognized NL.

may be used for specialized communications, e.g. Swahili for publishing extension materials or journal articles in Kenya.

- Virtually all nations of the world also have multiple local languages (LLs). For example, the SR-CRSP/ Peru works with producers of two LL groups: Quechua, the modern-day Inca tongue; and Aymara, a related but mutually unintelligible language. Work in Kenya likewise involves two LLs, Luo and Luhya. Field research and extension must often be conducted in such LLs.

Obviously, the more a development program utilizes this diversity of languages, the broader and more effective will be communication of its results and the greater its impact. Also, the ethical and professional concerns noted earlier will be better addressed. These and related considerations are highlighted in discussing SR-CRSP communications.

Technical Communications

Given the SR-CRSP's primary mandate of research, the majority of program communications fall into this and the following category of scholarly communications, which together comprise "scientific" communications (Table 3). Their principal intent is to inform. In contrast to scholarly works, however, technical communications are often fugitive in nature. This means they require extra attention in distribution.

Discussion Papers and Working Papers. These are produced primarily for "in-house" use within a country site, although they invariable also circulate among interested groups outside the program. HC and expatriate participants often co-author such papers. When written in the NL, they provide a comfortable medium for non- PL-speaking nationals of various professional levels to make inputs into program decisions. The papers also serve as a forum for getting critical feedback on what frequently become more formal, scholarly communications.

The best example comes from the SR-CRSP/Indonesia. In 1982 it established a multidisciplinary series of working papers that currently total nearly 100. Approximately 80% are co-authored by HC and expatriate scientists. Also, all program-sponsored students from Indonesia are strongly encouraged to publish in the series, drawing upon their MS or PhD research. Moreover, many of the papers have subsequently been revised and published in national (in PL or NL) and international scientific journals**.** Significantly, the SR-CRSP/ Indonesia's collaborating institution has established a clear cut reward system for reporting, with performance points awarded according to mode of reporting (working papers, technical reports, conference proceedings, refereed journal articles, etc.), seniority of authorship and breadth of audience (national versus international).

The Indonesia working papers are distributed in-country to a computerized mailing list of approximately 100, including other projects, individual non-program scientists and government policy makers. Perhaps more important, the papers are also permanently housed in university and institute libraries in Indonesia.

Technical Reports. At the suggestion of the Sociology Project (SP), in 1980 the SR-CRSP established a program-wide technical report series. Coordinated by the ME, the series currently totals 96 reports completed or in progress (Table 3). A signal feature of this channel is its flexibility. Any HC, expatriate and even non-CRSP participants can publish in the series. Moreover, authors may write in any language. In fact, 30% of all reports exist in one of the major SR-CRSP NLs (Spanish), Both cross-national and interdisciplinary collaboration are encouraged. Indeed, nearly half of all reports have co-authors of differing nationalities. (The remainder are more or less equally divided between HC and expatriate researchers, writing singly or as a team.) Finally, the series can accommodate any professional level. For example, field research assistants often figure as co-authors, and students have authored or co-authored approximately two-thirds of the reports.

This flexibility has made the technical report series one of the SR-CRSP's most successful and wide-ranging communication efforts and yet another stimulus to researchers of all career stages and nationalities to write. This has enhanced individuals' professional development while at the same time promoting critical intra-program and cross-disciplinary dialogue.

The ME circulates all technical reports following the contractual requirements for annual reports (see below). In addition, it files them with the US's National Technical Information Service, where they can be purchased on microfilm or in print. [8] However, because many people both in the US and abroad do not know about NTIS, cannot access it or find it too expensive, and because the ramifications of its potential privatization

[8] NTIS is "the central source for the public sale of US government sponsored research, development and engineering reports, as well as foreign technical reports and other analyses prepared by national and local government... Full summaries of current US and foreign research reports.. are published regularly by NTIS in a wide variety of weekly newsletters, a biweekly journal, and annual index and in various subscription formats for other Federal Agencies (US Government, 1987/88).

are unknown, SP has taken additional steps to make its reports more broadly, cheaply and perhaps permanently available.

First, all SP reports are housed in UMCs main library, both in archives and in circulating collections. Thus the documents are available gratis on interlibrary loan to any US university or public library. Also, online services such as UMCs International Agricultural Systems database index the reports.[9]

Second, SP reports are distributed to other specialized collections around the US, including Iowa State University's CIKARD and the University of Kentucky's Applied Anthropology Collection. Additions to the latter are listed in *The Anthropology Newsletter* and abstracted in *Practicing Anthropology*, which reach a total readership of 13,271 (as of August 1988). Moreover, a volume abstracting this collection has been published (van Willigen, 1980).

Third, the SP has sought additional outlets abroad for each of the world regions involved in the SR-CRSP. For example, for Africa, the reports are housed with OXFAM, ODI's Pastoral Development Network and the Commonwealth Agricultural Bureaux International. The latter includes over 30 abstracting services that index more than 8,500 journals, as well as monographs and conference proceedings, in 30-plus languages both online and in print For Latin America, the project is investigating distribution networks such as CIDA and AGRINTER, which circulate indices of agricultural publications throughout the region. Comparable bibliographic services exist for Asia, either independently or via global abstracting or indexing services such as FAO's AGRIS, which covers all branches of agriculture but focuses on developing countries and coordinates with information centers such as CIDIA in each world region.[10]

NL Monograph Series and Translations. In 1986 the Peru Community Studies Subproject created a simple monograph series-essentially a Spanish-language technical report series, but more attractively printed, bound and illustrated. Like the reports, this is a highly flexible outlet. Fernandez et al. (1986) is illustrative. The authors include an American, an American-Peruvian and a Columbian spanning BA, MA and PhD levels in economics, rural development and agricultural economics, respectively, at the time of writing. Two of these individuals were SR-CRSP direct hires while the third was employed by the national veterinary institute.

In addition to original Spanish-language texts, monographs include translations of works by US personnel who have conducted research in Peru (e.g. Bilinsky, 1986; Fernandez, 1986). Other studies by US researchers have been translated and released through non-program series in Peru (e.g. McCorkle, n.d., 1988). Both these strategies-NL monographs and translations-aptly address the concern that information gathered by expatriate researchers be returned to the HC in an accessible language and affordable form.

The NL monographs are locally produced in lots of 500 for an average of US$1.00 apiece. They have been distributed gratis through the subproject and through Peruvian bookstores at cost. Also, they are housed in the same collections as the SP technical reports. It is worth noting that demand for both these series has been such that the SP is now reprinting out-of-stock items.

Workshop Proceedings. Another outlet created by the SR-CRSP, workshop proceedings likewise serve to return research information to its country of origin. The best example is the SR-CRSP Kenya Workshop, held in that country annually. Established in 1982, this dynamic forum embraces SR-CRSP participants of all disciplinary and professional types plus invitees from organizations such as ILCA, ILRAD, the Kenya Ministry of Livestock Development, Kenyan universities and other entities working on animal agriculture in Africa. Knowing that their contributions will appear in print and that the workshop will be attended by members of important organizations representing potential funds and jobs, SR-CRSPers are eager to participate and "put their best foot forward" in preparing their workshop papers.

The SR-CRSP/Indonesia has also organized such workshops, taking care to publish proceedings in bilingual formats that reach the largest possible groups of national and international audiences (e.g. Rangkuti et al., 1984). Workshops and their proceedings disseminate relevant results regionally as well as nationally-as illustrated by the Kenya experience plus the 1988 SR-CRSP *Bolivian Workshop on Sheep and Alpaca Production* in La Paz (proceedings forthcoming).

Conference Presentations and Proceedings. These serve motivations and purposes similar to those of the workshops. The SR-CRSP has promoted professional conferencing for all its members, but particularly for students and HC collaborators of all levels-as when the entire teams of field interviewers and researchers from two study villages in Peru were financed to address a multinational conference on Andean agriculture (Anon., 1987). (For many more examples, see ME, n.d. and Table 3.)

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[9] However, a general lack of information on such local databases makes it difficult for research to learn of them, their indexing parameters and accessing procedures.

[10] For detailed information on such national and international abstracting, indexing and computerized reference services, see Liley, 1981.

Moreover, the SR-CRSP has found it valuable to create conferences and special sessions in order to increase both intra- and extra-program scientific communication. Examples from the Sociology Project alone include the following.

- A mini-conference that brought together US scientists resident in the HCs to compare methods and findings and to coordinate research directions.
- An SP session at the FSR/E Symposium (see Guillet, 1986 and Fernandez and Salvatierra, Gaylord and Bilinsky, Jamtgaard, McCorkle, and Mendes in Butler Flora and Tomecek, 1986). This reinforced cross-site communication while simultaneously disseminating findings to global scientific and development communities.
- A unique conference that assembled anthropologists and sociologists from five CRSPs to document their disciplines' evolving contribution to international agriculture.

More recently, all the SR-CRSP projects presented a block of ten overview papers at the 1988 meetings of the American Society of Animal Science. This illustrates one further conferencing principle on the SR-CRSP: disseminating results to disciplines other than one's own. This interactional strategy makes findings from one discipline ultimately more useful to, and used by, other FSR/E disciplines.

Unfortunately, distribution channels for workshop and conference proceedings are typically limited and asystematic, hence the need for other, more enduring outlets.

Scholarly Communications

The SR-CRSP generally and sociology in particular are increasingly emphasizing more permanent forms of reporting than the often fugitive literature of technical and other communications. This means turning to traditional, formal channels of scientific communication.

Journal Articles. Along with conference presentations and annual reports, this is one of the common forms of project reporting, so our remarks will be brief. To date, SR-CRSP participants have published over 200 refereed articles, with nearly another 200 submitted or in press (Table 3). Many of these articles have appeared in HC journals and languages. Many also represent interdisciplinary and cross-national collaborations. The SR-CRSP has found co-authoring helpful in motivating individuals to write more and "better." Temporal, linguistic, experiential and other constraints can often be overcome through judicious teaming of authors. Simultaneously, multiple disciplinary, cultural and linguistic expertise can be tapped, as well as a greater diversity of publishing outlets. Moreover, co-authoring plays an important role in junior researchers' and students' professional development.

Texts and Anthologies. Sociology has adopted an exceptionally aggressive plan to integrate and publish its findings in scholarly book formats, including the following:

- Two ethnographies of farming systems in highland Peru (Gilles, in progress; McCorkle, in progress-a).
- A cross-site anthology of SP research on agropastoralism, with work by SR-CRSP technical scientists, HC and expatriate social scientists and both aspiring and established researchers (McCorkle, in progress-b).
- Likewise, a compilation of studies on the sociology of range management, which includes both CRSP and non-CRSP authors (Gilles, in progress).
- Blocks of chapters on SP findings in other anthologies (e.g. Guillet in Browman, 1987).
- A volume on anthropology and sociology in international agriculture—a direct outgrowth of the cross-CRSP conference described earlier (McCorkle, forthcoming).

Nor have these efforts been limited to only one program, project, discipline, nationality or language. Again illustrating from the Sociology/Peru Project:

- A subvention for a textbook in Spanish by two Peruvian scientists-one an SR-CRSP range manager, the other an anthropologist not formally linked to the program (Tapia Nunez and Flores Ochoa, 1984).
- Support for a Spanish-language anthology with chapters by Peruvian, US, British and Japanese social scientists (Flores Ochoa, in progress).
- Likewise, financial assistance to the investigations of other non-program Peruvian researchers (including anthropologists and geographers) that promise to result in a Spanish-language book (e.g. Casaverde, in progress).

Such NL texts and anthologies can be produced fairly inexpensively in developing countries. For example, 1000 copies of a 300-page paperback text of 14x21 cm can be printed in Peru for only US$3000. Whether in the US or the HC, such initiatives have not been problem-free, and it remains to be seen whether all will reach completion. But the important point is that projects should plan for and actively support these more ambitious and synthesizing communications in both PLs and NLs.

Since scholarly communications are normally backed by journal subscriberships and publishing houses' marketing networks, this is one area in which distribution can usually be "left to take care of itself." Nevertheless, the SP has taken extra steps in special cases. For example, the project has applied for a grant to distribute 100 copies of the cross-CRSP volume within USAID, to insure that it reaches the larger, multidisciplinary and policy audiences for which it is intended.

General Program Communications

This category targets two main functions and receiver groups: intra-program communication and formal reporting to the donor agency. Most of the strategies listed here are familiar ones. Still, there are some useful lessons to be learned from the SR-CRSP's decade of experience.

Program Newsletters. These are a standby on most large programs. The SR-CRSP newsletter seeks "to popularize our research accomplishments for the benefit of donors and host country supporters and to communicate matters that relate to personnel changes, conferences, publications, awards, success stories, donor comment, upcoming events, 'CRSP alumni,' etc... research in progress, research results, including adoption/ impact and tech packs" (Oxley, n.d.). A computerized list of 107 recipients exists for the SR-CRSP newsletter. Recipients span all program components and relevant official, advisory, evaluative, etc. entities, plus individual requesters. However, production and distribution of the newsletter has been costly, time-consuming and at times haphazard. Hence, the program is reassessing its benefits.

Electronic Bulletin boards. Communicating among the 18 major HC and US institutions and the disparate disciplines in the SR-CRSP has always been problematic-and not just for research reporting (McCorkle and Gilíes, 1987). Recently, the program field-tested an international electronic network to tie together all the projects, country sites and USAID and other organizations. For internal communication, this strategy promises more frequent, direct and interactive links across the SR-CRSP's vast geographic and disciplinary distances than a newsletter published only a few times a year. Moreover, messages transmitted will be put to work generating more timely material for release through other channels.

Annual Reports. Across the life of the program, the obligatory annual reports have undergone conscious transformations in presentation to better match the donor agency's information needs. Reports have been shortened, their format tightened and their content re-organized to make for easier access to information about a given site or project. Often viewed as a dreary chore, annual reports nevertheless meet many internal communication needs as well. For one thing, they ensure that scientists will report their work at least once a year. They also force participants to communicate among themselves and keep the different projects abreast of each others' work. The documents are equally valuable in tracing program history, highlighting significant problems and issues and stimulating periodic re-thinking of directions and goals. Recognizing such benefits, some SR-CRSP sites have instituted more frequent monthly or quarterly reports of their own.

Bibliographies. Another contractual obligation is regularly recording scientific communications. On the SR-CRSP, initially these references were simply scattered throughout the annual report, making them difficult to access. So a separate, cumulative bibliography was designed instead (e.g. ME, n.d.). The uses and audiences for such documents are many and obvious. Interestingly, the donor agency has noted a high demand for these volumes outside the program and feels they effectively signal the wealth of SR-CRSP results.

Summary Publications. In 1983 the ME produced a handsome volume (Blond, n.d.) that-in clear English and liberally illustrated with photos, figures and tables-summarized the achievements of the program's first five years. The impacts and uses of this "slick" publication have been innumerable. Donor and program personnel alike constantly consult it for basic information on the SR-CRSP, and it has become a source book in international development circles. Each copy cost approximately $25.00 to print Coupled with editing and other fees, this made the volume an expensive proposition. Nevertheless, we would recommend that large, long-term projects explore this option. The benefits far outweigh the costs-so much so that the SR-CRSP is planning a second five-year summary in 1989.

Annual reports, bibliographies and summary publications are systematically circulated to NTIS, the donor agency, the SR-CRSP projects and country sites and advisory and administrative groups such as the BIR, EEP and JCARD. The summary volume has also been housed in various libraries.

Public Information and Polular Communications

This category targets multiple receiver groups (donors, policy-makers, global development communities and general publics) with the primary purpose of promotion, i.e. making a program and its achievements "visible" to wider audiences.

"Blurbs" in Non-Program Outlets. By "blurbs" we mean short announcements or press-oriented articles in outlets of other relevant organizations. Blurbs released through such channels can reach much larger and more diverse audiences than newsletters and at little or no cost to the project Some examples targeted by the SRCRSP are

- US and international newsletters (e.g. NASULGCs *International Letter*, the ILEIA newsletter) and agricultural development networks such as the ODPs;
- HC or regionwide networks such as Latin America's RISPAL, an animal production network linking CATIE, IDRC, IICA and INIPA/INIAA;
- magazines such as *Development International*, *World Animal Review;* donor outlets such as *BIFAD Briefs*, USAID's *Front Lines*, *Highlights* and S&T's *STAR;* and of course,
- the newsletters of relevant disciplinary associations.

Exhibits. Portable exhibit boards serve similar functions and are useful in many contexts-not only at conferences, meetings with donor groups, etc. but also at home institution events. The SR-CRSP commissioned roughly a dozen copies of a professionally produced, 56"X84" exhibit board about the program, with spaces left for the different projects to add photos and blurbs of their own. Produced in this quantity, each display costs only $150.00.

Pamphlets and Brochures. On the SR-CRSP, these have been/should be available for locating the program in its broadest, Title XII context; over viewing the SR-CRSP as a whole; describing a given country site and/or project; and sending focused messages or exploiting special events (such as the Sociology "Highlights" pamphlet distributed here at the FSR/E symposium). Pamphlets and brochures are an especially versatile way to increase program visibility because they can often be quickly and inexpensively designed to focus on any level of project operations and any receiver group along a continuum from very general to very specific. Another advantage is that they can be widely distributed not only by mail but also by hand-in protocol meetings, at scholarly conferences or to visitors. Whether in the US or HCs, production of modest pamphlets and brochures is very inexpensive.

Press Releases. Here we refer to news items released through home institution outlets such as campus or institute newsletters and newspapers, plus common mass media such as local and national newspapers, television and radio in the US and HCs. This is the single most neglected kind of reporting on projects despite the importance of public awareness in marshalling long-term support for FSR and in informing farmers of new agricultural advances. Unfortunately, here the SR-CRSP is no exception. However, experiences in Peru, Indonesia and the US indicate that the media are often happy to cover SR-CRSP events or release news items if program personnel take the trouble to inform them or, in HCs, even to file such releases. There are possibilities for radio and TV interviews, too. Radio is a particularly crucial medium in countries with high illiteracy rates.

Little need be said about the obvious distributional and cost/benefit value of such channels, other than to reiterate that projects need to pay much more attention to them and to the large local and national audiences they reach in both donor and HC nations.

Slide-tapes and Videotapes. These are also frequently neglected yet very versatile and powerful strategies for increasing project visibility. A good example is the SR-CRSP videotape on Indonesia (Beck Yazman, 1985). Produced in both English and Indonesian and in both Beta and VHS, it has been screened for such diverse receiver groups and contexts as Indonesian farmers and extension agents; visitors to the country site, including Indonesian government officials; USAID presentations; CRSP directors' meetings; poster sessions at international conferences; SR-CRSP participants generally; and even university department review committees. Possibilities for showing the tape on Indonesian and US television are also being explored.

A distributional advantage is that these compact materials "travel well." Program participants of almost any professional or disciplinary type can easily screen them wherever basic projection equipment is available. Another advantage is that, with dubbing into NLs (a small expense), they can be released through HC as well as donor-nation mass media. Their outreach potential is therefore vast.

Although slide-tapes and videotapes can be expensive, "one picture is worth a thousand words." Based on the success of the Indonesia initiative, production of videotapes for Kenya and Peru is now being explored. Collaboration with PVOs (Kenya) and use of HC crews and film archives (Peru) can slash expenses. For example, while the Indonesia tape cost some $18,000 using US personnel and equipment, an equivalent video documentary can be made by media centers in Peru for only $3,000. Slide-tapes are, of course, much cheaper; and often they can later be transformed into videotapes.

Specialized Communications

Given SR-CRSP mandates, specialized communications span two areas-training and extension.

Theses and Dissertations. These are an outgrowth of the program's training function. To date, SR-CRSP BA and MS theses total 132, and dissertations number 42, with many more in progress. These documents circulate through established channels such as libraries and University Microfilms International. However, many SR-CRSP theses and dissertations have also been revised and distributed as technical reports, thus reaching much larger audiences.

Extension Materials. To be truly effective, research results must also reach extensionists who can put the information to work by interpreting, repackaging and disseminating it to the final audience-the farmers-for whose benefit agricultural development projects are mounted in the first place. But as we all know, there is often a glaring communication gap between R and E, between generating information and presenting and distributing it to those who can best put it to work. Hence the SR-CRSP is preparing country-specific summaries of findings (e.g. Berger et al., forthcoming; Johnson and de Oliveira, forthcoming), spelling out their potential hands-on applications to different farming systems. These "technology packages" are designed for extension agents' direct use in the field and/or for HC subject matter specialists' use in training agents or preparing field materials. Naturally, these manuals are produced in the NL as well as English. In addition, some sites (Kenya) have elaborated LL extension materials for farmers. An interesting example is a quadrillingual (English, Swahili, Luo, Luhya) manual on goat husbandry for Kenyan producers (Semenye, n.d.).

A MODEL FROM THE SR-CRSP

The types of, and rationale behind, the multiple communication strategies utilized by the SR-CRSP illustrate alternative ways to accommodate the immense diversity in professional levels, languages and disciplines and in scientific, donor, beneficiary and public audiences pertinent to FSR/E. Taken as a whole, these experiences suggest an idealized communication model that can be adapted to fit the needs of other projects or programs (Fig. 2).

The word "adapt" is important here. Realistically, no one project can or should adopt all these strategies for all sites and operations. For example, translation costs alone would be staggering if every item displayed in Fig. 2 were produced in all relevant languages. In fact, as our overview of SR-CRSP communication strategies documents, each country site and project innovated and selected among differing information, presentation and distribution options to meet its unique needs.

Rather, this idealized model should be used on analogy with a cafeteria, from which a given project can select its own communication menu. Certain outlets may be chosen as the "meat and potatoes" of program communication—e.g. on a research-oriented project, perhaps the traditional standbys of technical and annual reports and journal articles. Other outlets such as blurbs, exhibits, brochures, etc. function as "appetizers," referring readers to main-course communications. Still others may be served for special functions and "dessert" (e.g. "slick" summary publications or videotapes) along with the wine of scholarly texts and anthologies. Country-specific variations on the menu can be achieved through translation and publication in HC outlets.

However, selection of the communication menu must be carefully prioritized according to multiple factors. To reiterate just a few:

- the project's mandates (research, extension, training, policy advising) and hence its primary communication needs;
- characteristics of the target receiver groups-e.g. language, literacy, constraints on time, preferred channels of communication and information needs and interests relative to the project;
- the availability and outreach of existing, as well as creative new, information outlets-e.g. various print modes, infrastructure for mass media, electronic and projection equipment; and
- the relative human and financial costs of utilizing different channels.

In other words, "Who needs to communicate what to whom, and what is the best and most cost-effective way to do it?" On the question of cost, the SR-CRSP experience offers some important insights. Savings in both human and financial terms are realized in considerable feedback and feedforward among the model's categories. Communications of one type can often be readily revised, combined or summarized to derive items of another type that can then be re-channeled to additional receiver groups.

Examples already noted are revising working papers to become scholarly articles; reproducing portions of theses and dissertations as technical reports; releasing technical reports as NL monographs and through other NL channels; turning workshop and conference papers into both PL and NL proceedings, scholarly articles and entire books; generating press releases from items in newsletters and electronic bulletin boards; and transforming slide-tapes into videotapes. Naturally, too, all scientific communications feed into annual reports, bibliographies, summary publications, extension materials, blurbs, brochures and exhibits.

Other, less common examples are the sociology "Highlights" pamphlet, which originally constituted part of an annual report; the ten conference papers, which are now being edited for publication as a special section in a major scholarly journal; and this FSR/E Symposium presentation, which the authors hope to make into a slide-tape. In fact, the feedback and feedforward loops are almost infinite.

Savings are realized in other ways, too. Active distribution of program materials to existing archival and other dissemination services relieves a project of much of the burden of performing these tasks itself. A simple circular can refer requests to these sources. At the same time, such services disseminate information from and about the project far beyond any means at its own disposal and at almost zero cost. Equally cost-effective are blurbs in other organizational outlets and outreach through mass media. The latter in particular is a sadly underutilized but powerful channel for communicating with home institutions, donors, policy makers and the public.

CONCLUSION

For a plethora of reasons-ethical, professional, scientific, administrative and practical-FSR/E and related projects have an overarching need to communicate effectively with all relevant receiver groups. But communication within and across these groups does not just "happen" automatically. Quite the contrary, as numerous studies attest. Agricultural R&D projects that are sincere about being effective must therefore make a formal (but flexible) plan and commitment to this task. Otherwise, they are unlikely to fulfill their primary mandates: to improve agricultural productivity and farmer well-being, inform policy making and guide future research. Unfortunately, many projects to date have been characterized by very weak information management, to put it mildly.

Lessons learned from a decade of experience on the SR-CRSP highlight common communication needs and problems in international agricultural development at the same time that they offer some workable and cost-effective solutions. These lessons can be broadly summarized as a set of recommendations to other projects.

- Establish a communication plan and earmark funds and personnel for the full information/presentation/ distribution process. To realistically implement this plan, someone needs to be responsible for it. Ideally this should be a professional agricultural communicator experienced in the multiple media, reporting outlets and information services pertinent to FSR/E. When the job of communicating project results is at once everyone's and no one's, it may simply "be left to take care of itself."
- Look for cost and time saving feedback and feedforward opportunities during communication planning and implementation.
- Devise motivational strategies (e.g. co-authoring, conferencing), reward systems and fresh outlets (e.g. technical reports and NL monograph series, special scholarly texts and anthologies) for reporting by project participants of all levels in both PLs and NLs.
- Relatedly, be sensitive to linguistic appropriateness vis-a-vis different target audiences.
- Streamline and reorganize contractually required documents (e.g. annual reports, bibliographies) to better respond to funding agencies' information needs.
- Investigate the costs and benefits of one or two extraordinary informational pieces like "slick" summary publications and slide-tapes or videotapes.
- Pay attention to public information and popular communications—especially inexpensive options such as blurbs, brochures and low- or no-cost exposure in the mass media; and be sure not to forget home institution outlets and events.

- Exploit recent advances in electronic media (if feasible) and certainly in information sciences. In particular, utilize US, HC and international archives and clearinghouses, information retrieval systems and abstract, reference and database services to expand dissemination of project information.

The importance of this last recommendation cannot be overemphasized. Without dynamic distribution, the information/ presentation process-and the project itself-are obviated. Projects and programs easily come and go, leaving behind little institutional memory. Therefore, exploiting more stable, non-program dissemination outlets is imperative if FSR/E is to avoid costly "reinventions of the wheel" and have sustainable impacts.

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ACRONYMS AND ABBREVIATIONS

ADC	Agricultural Development Council
AGRINTER	Sistema Interamericano de información para las Ciencias Agrícolas
AGRIS	International Information System for the Agricultural Sciences and Technology (of FAO)
BIFAD	Board of International Food and Agricultural Development
BIR	Board of Institutional Representatives
CABI	Commonwealth Agricultural Bureaux International
CATIE	Centro de Agricultura Tropical de Investigación y Enseñanza
CCTA	Comisión para la Coordinación de Tecnología Andina
ODIA	Centro Interamericano de Documentación e Información Agrícola (of IICA)
CIID	Centro Internacional de Investigación para el Desarrollo (IDRC)
CIKARD	Center for Indigenous Knowledge for Agricultural and Rural Development
CIRDAP	Center on Integrated Rural Development for Asia and the Pacific
EEP	External Evaluation Panel (of the SR-CRSP)
FAO	Food and Agriculture Organization
FSR/E	Farming Systems Research and Extension
HC	Host Country
IARC	International Agricultural Research Center
IDRC	International Development and Research Centre
IICA	Instituto Interamericano de Ciencias Agrícolas
IIDSA	Instituto de Investigación para el Desarrollo Social del Altiplano
ILEIA	International Centre for Low External Input Agriculture
ILCA	International Livestock Centre For Africa
ILRAD	International Laboratory for Research on Animal Diseases
INIAA	Instituto Nacional de Investigación Agropecuaria y Agroindustrial (of Peru)
INIPA	Instituto Nacional de Investigación y Promoción Agropecuaria (of Peru)
IRRI	International Rice Research Institute
JCARD	Joint Committee for Agricultural Research and Development (of Bifad)
LL	Local Language
ME	Management Entity (of the SR-CRSP)
NASULGC	National Association of State Universities and Land Grant Colleges
NL	National Language
NTIS	National Technical Information Service (of the US)
ODI	Overseas Development Institute (of the UK)
PL	Program Language
PVO	Private Voluntary Organization
R&D	Research and Development
RISPAL	Red de Investigación en Sistemas de Producción Animal en Latinoamérica
SP	Sociology Project (of the SR-CRSP)
SR-CRSP	Small Ruminant Collaborative Research Support Program
S&T	Science and Technology Bureau (of USAID)
UK	United Kingdom
UMC	University of Missouri-Columbia
UMI	University Microfilms International
US	United States
USAID	United States Agency for International Development
USDA	United States Department of Agriculture

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TABLE 1. SR-CRSP COMMUNICATION NEEDS

Major Receiver Groups	Host Country	US	Global/ Regional
Scientists and academicians	x	x	x
Development donors and practitioners	x	x	x
Citizenry at large	x	x	
Relevant government donors, policy makers, bureaucrats	x	x	
Program and project participants at all levels, including ME	x	x	
Home institutions of participants	x	x	
Extension personnel and farm families	x		

TABLE 2. COMMUNICATION STRATEGIES ON THE SR-CRSP[a]

Technical Communications[b]
Discussion papers and working papers Technical reports NL monograph series and translations Workshop proceedings Conference presentations and proceedings
Scholarly Communications[b]
Journal articles Texts and anthologies
General Program Communications
Program newsletters Electronic bulletin boards Annual reports Bibliographics Summary publications
Public Information and Popular Communications
Blurbs in non-program outlets Exhibits Pamphlets and brochures Press releases Slide-tapes and videotapes
Specialized Communications
Theses and dissertations Extension materials

a - Typically any one strategy can be used for multiple types of receivers (in the appropriate language) and purposes (to inform, inspire, instruct).
b - Together these two categories comprise "scientific communications."

TABLE 3. SR-CRSP SCIENTIFIC COMMUNICATIONS[a]
SR-CRSP Projects

Mode of Communications	Sociology	Economics	Range/ Forage	Nutrition	Breeding/ Genetics	Repro-duction	Animal Health	Production Systems	Systems Analysis	Total
Books[b]	7	3	1	1	0	0	1	0	0	13
Chapters in books	10	5	4	7	33	8	2	10	0	79
Refereed articles	25	16	38	30	45	4	50	6	6	220
Journal articles submitted or in press	11	19	25	18	51	4	37	6	2	173
Technical communications[a]	134	111	107	61	221	37	29	65	0	765
PhD dissertations	2	2	15	3	11	3	5	1	0	42
BS and MS degrees/theses	8	10	20	33	28	17	11	5	0	132
Abstracts	9	20	125	93	221	43	76	15	14	616
Oral presentations	37	8	48	25	17	7	40	7	0	189
Total	243	194	383	271	627	123	251	115	22	2229

a – As of August 1988 based on ME n.d. plus SP annual report for 1987-88, with figures compiled by R. Primov and C. McCorkle, respectively.
b – Published, in press, under contract, or in progress.
c – Includes technical reports, proceedings papers, and presentations at scientific meetings, conferences, ad workshops.

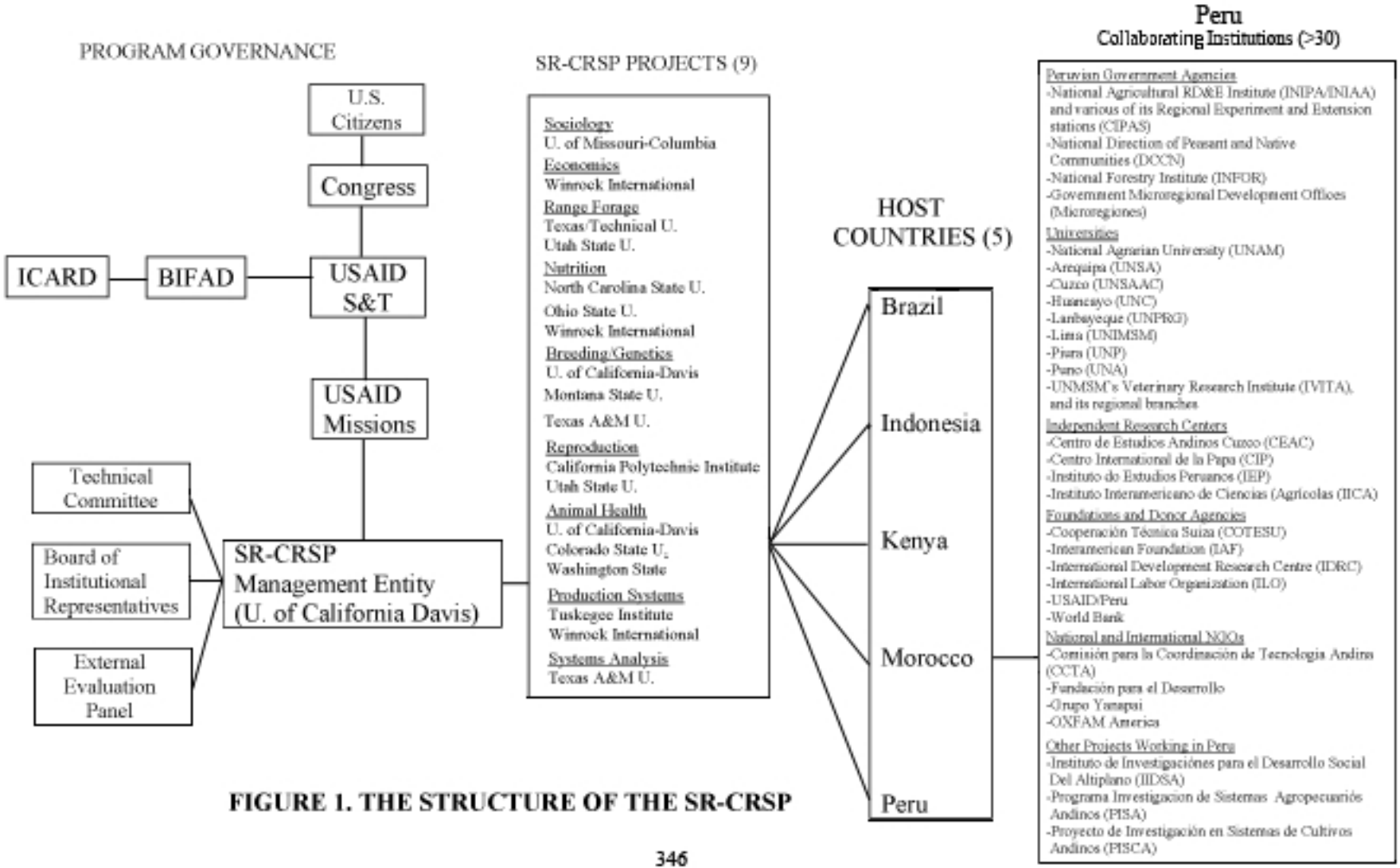

FIGURE 1. THE STRUCTURE OF THE SR-CRSP

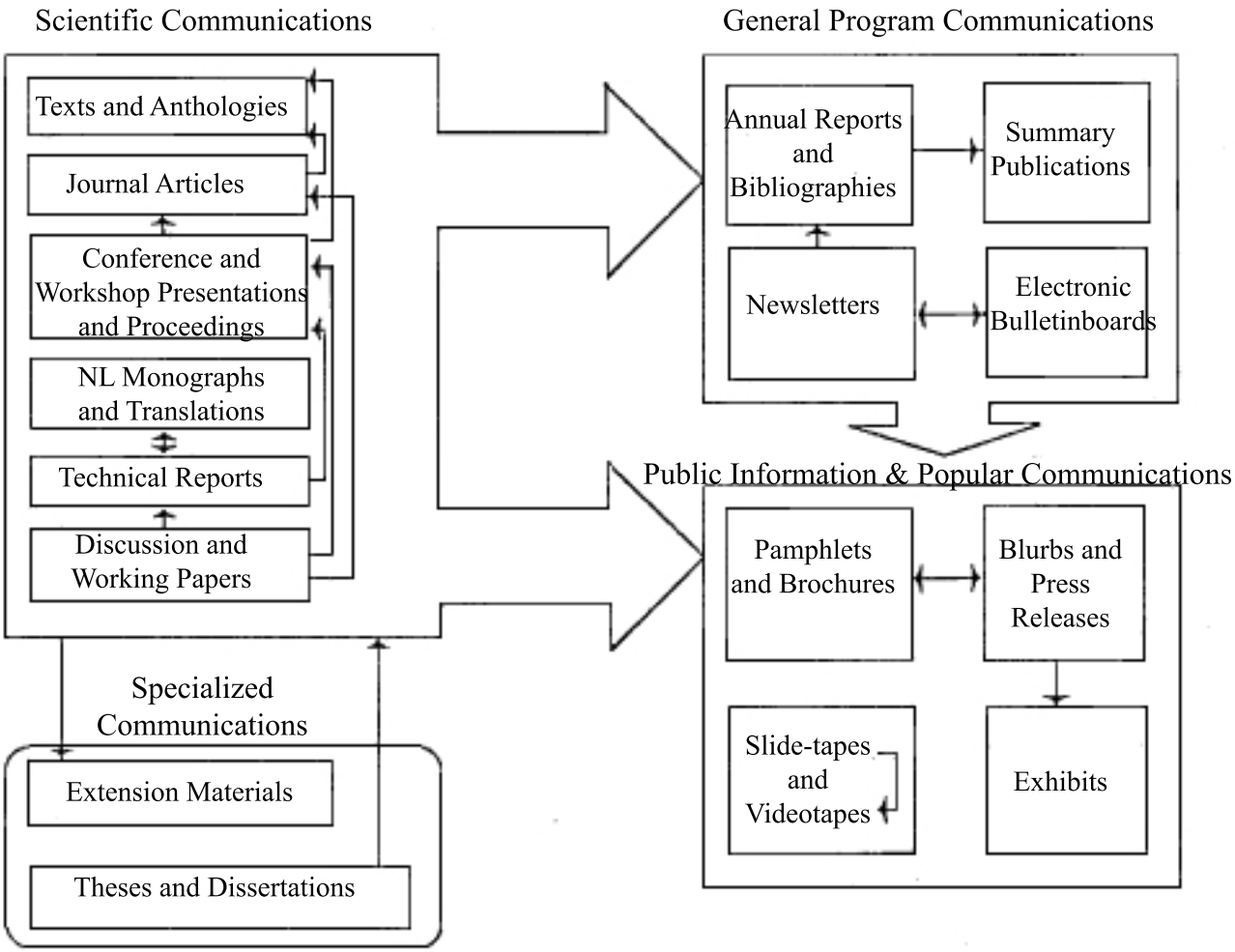

FIGURE 2. A MODEL FROM THE SMALL RUMINANT CRSP

Special Topics Papers:

Agroforestry

AGROFORESTRY IN MILLET-AND SORGHUM-BASED CROPPING SYSTEMS IN THE SEMI-ARID ZONE OF NIGERIA: THE CASE OF *ACACIA ALBIDA* DEL.

N. A. Gworgwor[1]

INTRODUCTION

The semi-arid zone of Nigeria is comprised of Sahel, Sudan and part of northern Guinea savanna, constituting about 30% of the land in Nigeria (Ojanuga, 1987). It covers an area of about 222,000 km^2 roughly defined by latitude 10°N at the most southern extension to the Niger-Nigeria frontier and longitude 2°44'E to 14°42'E (Kowal and Knabe, 1972; Ojanuga, 1987) (Fig. 1). The region cuts across Sokoto, Katsina, Kaduna, Kano, Bauchi, Borno, Plateau and Gongola states of Nigeria.

Climate

The climate of the region is characterized by distinct wet and dry seasons (Kowal and Knabe, 1972). The onset of the rainy season, duration, distribution and time of cessation of the rains vary with latitude and seasons as well as months and years (Kowal and Adeoye, 1973). The duration of the rainy season is short, extending from June to September. Evaporation exceeds precipitation except for a month during the rainy seasons due to prevailing high temperature and low humidity (Fada and Rayar, 1988). Mean annual rainfall is between 1016 mm in the wettest part of the southern border of the region and less than 508 mm in the driest northern part (Ojanuga, 1987) (Fig 1).

Soil

According to Ojanuga (1987), the soils of the regions are mostly Aridisols and Entisols. Over most of the region, the soils are predominantly sandy, at least at the surface; this soil type is related to many of the problems of moisture control and soil management in the area (Fada and Rayar, 1988). According to Bababe (1988), the high dispersion, poor state of aggregation and lighter texture of these soils indicate greater susceptibility to wind and water erosion. A unique feature of these soils in the region is low content of organic matter (less than 1%) and total nitrogen (N) due to low biomass turnover as a result of scanty rainfall (Owonubi and Yayock, 1981; Ojanuga, 1987; Fada and Rayar, 1988). The inherent low fertility levels of the soils are further attributed to rapid mineralization of the little organic matter added to the soils by intense solar radiation and microbial activity (Ojanuga, 1987).

Vegetation

The vegetation cover of the semi-arid region as reported by Crowder and Chheda (1977) is characterized by many scattered single trees growing to a height of up to 10-15 m, especially in the southern part of the region. The trees become shorter (2-3 m) and gradually merge into shrubs with thorns northwards. Trees are mostly deciduous with deeply penetrating and spreading roots. Dominant species include *Acacias* and *Euphorbia.* The predominant types of grass in the region are *Andropogon* and *Cenchrus* spp., although many other genera exist in the localities.

Farming System

Agriculture employs about 70% of the population of the region, with animal husbandry forming one of the main occupations of the people (Owonubi and Yayock, 1981). These activities are, however, at subsistence level. The most common crops grown are millet *(Pennisetum* spp.), sorghum *(Sorghum bicolor)* and groundnut *(Arachis hypogaea)* in the most northern parts while sorghum, groundnut, maize *(Zea mays)* and cotton *(Gossipium* spp.) are grown in the southern part. These are mostly grown in mixtures and hardly sole. The mixture combinations include cereals/cereals and cereals/legumes.

The people manage about 90% of the estimated 8-11 million head of cattle in Nigeria and more than 65% of the goats and sheep, estimated at 22-27 million and 27 million, respectively (Isichel and Ero, 1987; Oguntoyimbo et al., 1978), under the traditional nomadic or transhumans system.

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ACACIA ALBIDA DESCRIPTION AND DISTRIBUTION

Acacia albida Del. is also known as *Faidherbia albida* (Del). A. Chev. It is commonly referred to in West Africa as "Gawo" in Hausa and in Arabic as the "haraz." It is a tree of the leguminous family and of the subfamily Mimosoideae. It is characterized by bipinnate leaves, orange curled seed pods, cream-colored flowers and small thorns.

It is the fastest-growing tree among the savanna drought-resistant trees (Anon. 1975), reaching heights of 3-10 m in 10 years, depending upon environmental conditions (Wickens, 1969). It can be grown as a shrub if continually grazed (Wickens, 1969) but usually develops into tree with a large spreading crown. The mean maximum height is 25 m, with a girth of 5 m (Anon. 1968). It is a long-lived species, with an average life span of 70-90 years in the Sudan, and has been known to live more than 150 years in Zambia (Wickens, 1969).

Acacia albida has an extensive taproot system that develops rapidly to reach an adequate moisture layer. This characteristic makes the species relatively drought-resistant. On coarse, alluvial sands of the Sudan, a six-month-old seedling with 8 cm of aeral growth had a taproot of 70 cm (Wickens, 1969). In northern Nigeria, a three-year-old seedling produced a taproot in excess of 9.9 m (Weber, 1978).

The most unusual phenological characteristics of the species is retention of the leaves during the dry season and shedding of leaves at the onset of the rains during the wet season. Thus all over the semi-arid region of Nigeria, during the wet season, *Acacia albida* are seen standing on the field as dead and dry trees, which is why the Hausa people refer to it as "gawo" tree, meaning a dead tree. No other African savanna species is known to posses this reverse deciduous cycle (Wickens, 1969; Weber, 1978).

Acacia albida is found in all regions of long dry season from southern Algeria to the Transvaal, from the Atlantic to the Indian Ocean (Giffard, 1964). Heavy stands are found in Western Senegal, bordering the rivers in Mali, in all parts of Burkina-Fasso, near the villages in southern Niger, north of Nigeria, in the Logone Valley of Tohad, in the plains of Cameroons, throughout Kenya, Tanzania and Zambia (Giffard, 1972; Wickens, 1969; Weber, 1978) (Fig 2). Its usual associates are *Cambretum glutinosum, Adansonia digitate, Sterculia setigera, Grewia bicolor* and other *Acacias.*

Rainfall and Soil Requirements

Acacia albida prefers deep sand in the 650-mm (25-in.) rainfall belt. However, it survives under more arid conditions as low as 300 mm (12 in.) of annual rainfall where it is the only tree of any importance or size (Giffard, 1972). The tree characteristically grows in deep, well-drained sandy soils, but it also grows rapidly in fertile soil or clay soils with a permanent water table (Wickens, 1969). Weber (1978) indicates that it may be found anywhere millet can grow. Typically it occurs on bush-fallow of cultivated fields or land grazed by livestock, and it rarely occurs in natural woodlands that have not been exploited by man (Kirmse and Norton, 1984).

Agropastoral System in the Semi-Arid Zone of Nigeria

Agroforestry can be defined as the use of forest trees on farm land and their integration within farming or agropastoral systems. It is an ancient technique for maintaining soil fertility in marginal environments and has been used for centuries in rural civilizations in various parts of the world. Agroforestry has also been developed in montane areas and in the wet tropics. In each case the appropriate trees adapted for the different ecological zones are being exploited for agroforestry purposes (Poschen, 1986).

In Nigeria, *Acacia albida* grows favorably in the hot, drought-prone areas of the semi-arid region with very little rainfall in a year. Honerou (1980) observed that *Acacia albida* is protected and kept in millet fields among the peasant Serere people of Senegal. In Maiduguri, a survey showed that about 12-30 stands of *Acacia albida* per hectare are common on the field of farmers, mostly around or near by the villages, but the density decreases (6-17 trees/ha) as one goes away from the villages. This suggests that the tree thrives well on disturbed land. Thus, tilling encourages the growth of the tree. In Senegal, tree density is about 10-50/ha with a canopy diameter of 5-10 m. Canopy cover is thus 2% to 40% of the ground area (Honerou, 1980).

The growing of millet and sorghum is possible under and in between the trees as light interception by tree canopy during the growing season is negligible because the leaves are shed at the beginning of the rainy season. Furthermore, the shed leaves are easily incorporated into the soil as the land is being cultivated in preparation for planting, which becomes a very good organic manure to the crops. It has been calculated that the leaves entering the soil are equivalent to fertilization of up to 50 tons of manure/ha/year in dense stands of 50 large trees/ha. However, the figure is probably more like 10 ton/ha/year. Again, the amount of organic matter in

the upper layers of the soil is twice as high under *Acacia* as it is on open ground (Charreau and Vidal, 1965). The geobiogenous elements returned to the soil annually through the litter (in kg/ha/year) with a population of 16 trees/ha covering 24% of the ground were found by Charreau and Vidal (1965) to be as follows: Ca, 120; Mg, 25; K, 13; N, 75; P, 12; and S, 20.

Overall microbiological activity is 2-5 times higher under *Acacia* (Jung, 1970). Mineralized nitrogen content is also 2-5 times higher, while phosphorus and other elements are also sharply increased (Charreau and Vidal, 1965; Jung, 1970; Giffard, 1972; Dancette and Poulain, 1969).

Influence on Crop Yield

In the semi-arid zone of Nigeria, most farmers around Maiduguri who grow millet and sorghum on fields with stands of *Acacia albida* expressed satisfaction with the increment of the yield of their crops compared to those grown on fields with *no Acacia* stands. They also observed that the crop growth was more vigorous under and around the *Acacia* tree than far away, and that continuous growing of the cereal crops on the field with *Acacia* never decreases but somehow stabilizes yield yearly.

Similarly, Jung (1970), Dancette and Poulain (1969) and Charreau and Vidal (1965) reported that millet production in the system is almost twice that obtained from purely open-land farming systems without fertilization, the conditions found in West Africa. The yield increases reported were 1,000 to 1,500 kg grain/ha/year under *Acacias* compared to 500-800 kg grain/ha/year on an open field.

Poschen (1986) from the study of *Acacia albida* in the agropastoral system of the Hararghe highlands of Eastern Ethiopia reported that yields of sorghum and maize were on the average substantially higher under the tree canopy than outside (Tables 1 and 2). On average over all the 27 plot pairs, the grain yields (consisting of sorghum and maize) under the trees were 2.42 tons/ha (gross area occupied by the tree) compared with 1.55 tons/ha in "without tree" plot, an increase of 56% under the canopy.

Poschen (1986) reported that the increase in yield under the trees is caused by the cumulative effects of slight improvements in grain weight and the number of grains per plot coupled with the somewhat higher plant densities under the tree. Increases for maize are higher than for sorghum both in absolute and relative terms. The vegetative growth of sorghum was stimulated as well under the *Acacias*, with stalk weight about 50% more and roots almost twice as heavy as compared with the plants in the open (Table 1). Furthermore, the 48% increase in number of grains per plants was substantially more favorable just before and during flowering and grain development. Similar studies have shown that soil structure and micro-climate improves under *Acadca albida* (Dancette and Poulain, 1965; Dugain, 1960; Jung, 1967).

Poschen (1986) also reported that morphology and shape of the tree apparently exert a decisive influence on crops, especially sorghum. Yields under the trees compare most favorably when the canopy is dense to medium dense. Organic matter and nitrogen influx are highest from leaf-shedding at the onset of the rains. It is important, however, that the tree branches should be well above the sorghum heads. Very low tree crowns can lead to depressions in sorghum yields.

Other agronomic studies revealed that there is 37% increase in groundnut and 104% in grass crops grown *under Acacias* (Poulain and Dancette 1968; Gautreau, 1966).

Additional Benefits

While crop yield improvement constitutes the most important single benefit from the presence of *Acacias* on crop lands, there are other advantages such as fodder, fuel wood provision, soil improvements, desert control, and other uses.

Fodder Supply. Because of its beneficial qualities as an important dry-season fodder, source of fiber, a shade during the hot period of the year and a preferred location for crop production (McGahuey and Kirmse, 1977), *Acacia* is a protected species in many parts of the sahel (Dancette, 1968).

In the semi-arid zone of Nigeria, *Acacia albida* often provides a very important source of fodder for animals who are loose during the dry season. They are seen roaming free, scavenging for fodder. They depend on shorter *Acacia* trees, and the farmers cut the branches for their livestock. Similarly, the animals gather under the trees to eat the fallen pods during the dry season when forages are limited. Blancou et al. (1977) have shown that browse is a very important component of dry-season diet for cattle in the sub-tropics, providing the principal source of protein and carotene. Reports of the crude protein content of *Acacia albida* leaves range from 14 to 17%, and three studies of the chemical composition of pods showed an average of 12.2% crude protein (Wickens, 1969). The highly nutritious and palatable pods and leaves of *Acacia albida* are readily consumed by all domestic and wild herbivores. Nomadic herdsmen typically lop the branches to provide browse

for their stock; the seed pods fall to the ground in March/April during a time of nutrient stress for sahelian herbivores (Kirmse and Norton, 1984).

Dense stands of the tree can provide a forage equivalent, from pods alone, greater than any other local forage on a per-hectare basis (Charreau, 1974) (Table 3). A wood savanna in which *Acacia albida* is the dominant tree species is able to stock 20 animals/km^2 as compared with 10 animals/km^2 when *Acacia albida* is not present (Giffard, 1964).

Fuel wood source. Fuel from *Acacia albida* is obtained through pruning and eventually by felling old trees. The pruning yield comes to almost 0.4 - 0.5 m^3 per mature tree when about 20-35% of the total tree volume is removed. Most farmers prune once every 4 to 5 years; thus an average 0.1 m^3 of fuelwood is obtained per mature tree annually. Felling *Acacias* is not very common (Poschen, 1986).

Soil improvement. It is an observed fact by the local farmers in the semi-arid zone that *Acacia albida* enriches the soils of their field. They usually do not supply artificial fertilizers to their millet or sorghum, yet they obtain very good crop growth and yield. According to Giffard (1972), the main use is its ability to fertilize and restore the soils while allowing cultivation under its shade. Because of its habit of shedding during the rainy season, it is tolerated on farmlands by the farmers because it gives no shade during the rains but shades the land during the hot dry season when it is in full leaf. It has been calculated that 15 trees/acre are sufficient to maintain permanent soil fertility (Giffard, 1972). Studies by Dugain (1960) in Niger indicate that on a 10-cm-depth basis, which represent about 1,500 tons of soil/ha, the nutrient increase due to the presence of Acacia albida was equivalent to the following amounts of fertilizer amendments per year: 300 kg nitrogen, 31 kg phosphorus as P_2O_5 and 24 kg magnesium. The tree also serves as soil protectant, minimizing soil erosion and serving as a wind break that protects crops and native vegetation from mechanical damage and excessive transpiration (Dancette, 1968).

Desert control. *Acacia albida* seems to be a suitable tree for checking desert encroachment as a sound ecological and socially accepted tree by the people of the desert prone semi-arid zone of Nigeria. Kirmse and Norton (1984) reported that it is possible to establish *Acacia albida* plantations in the sahel to check decertification as demonstrated in Tchad.

Other uses. The wood of *Acacia albida* is hard and favored locally for the construction of mortars and pestles as well as other light carpentry. Localized uses also include charcoal production and dug-out canoe construction. The big branches are mainly used for building huts and fencing construction. The bark can contain up to 28% tannin and is used for treating hides (Anon, 1968) and for gum. Pods and leaves are used medicinally.

INCORPORATION INTO CROPPING PATTERNS

Motivation and Attitude of Farmers

Most of the farmers around Maidurguri have a very positive attitude towards the species. They have accepted the fact that the advantages of *Acacia* outweigh the disadvantages, especially in areas of crop improvements, fodder and fuelwood provision. Similar findings were reported by Poschen (1986) in the highlands of Ethiopia. However, this observation cannot be extrapolated to large areas, because according to Poschen (1983), it was clear that only those farmers already having *Acacias* in their fields took a positive view. *Acacia albida* is exceptional, however, in that once its positive effect on crop production is recognized in an area, it is allowed to establish in densities much higher than that of any other tree species.

Silvicultural Problems

Acacia albida can be propagated either naturally or by artificial means. Natural regeneration of the species is both stimulated and repressed by grazing animals. The seed pods are highly palatable, and livestock can distribute the seed 150 km from the source while ruminant digestive juices stimulate seed germination (Weber, 1978). With increased grazing pressure and more intensive cultivation, however, natural regeneration is becoming more difficult for all perennials of the sahel, including *Acacia albida.*

The artificial propagation that involves raising of seedlings in nurseries and transplanting is faced with two basic problems yet to be solved satisfactorily: the survival of the seedlings and the growth rate of those that survive. The species is very sensitive to mistakes during seedling production and transplanting (Poschen, 1986). Conventional methods can result in high survival rates if proper care is taken. For example, as reported by Poschen (1983) in the highlands of Ethiopia, *Acacia* showed 50 to 90% survival nine months after transplanting and 74% after two years. Giffard (1964) also reported that slight mistakes in timing can reduce survival rates to 6% in the first year. Better results in this regard may be attained by using plastic containers with a length of 30

cm instead of the normal 20 cm for raising seedlings. Furthermore, Felker (1978) mentioned that another problem that would remain even with satisfactory survival rates is the vast differences in the performance of seedlings from the same batch because of the heterozygosity of *Acacia albida* seeds. This may be overcome by propagation from cuttings or by evolving appropriate methods for early testing in nursery beds. *Acacia albida* is generally slow growing. However, some genotypes can grow as fast as 1.6 m/year in height and 2.9 cm in diameter. Assuming a mean annual increment of 1.2 m in height and 2 cm in diameter, it would take 20 years to let a tree grow to a size at which it can substantially improve yields of under planted crops. This would still be an improvement over the 35 to 40 years that they probably take at present (Poschen, 1986).

The Sparse Stand

The distribution of the *Acacia* in the semi-arid zone is uneven with localized heavy stands and generally sparse stands all over the area. This could be a result of the almost exclusive reliance on natural spreading by migration, which is a slow process, given its moderate growth rate, relatively late flowering and heavy pods. The rate of spreading is enhanced through animal droppings but drastically affected by browsing goats and sheep. It is only in areas with high densities of human population, such as the Maiduguri area in which most of the land is cultivated and free grazing is restricted, that the *Acacias* can gain ground. It is, therefore, obvious that a good stand of *Acacias* can be maintained only if rigorous and concerted efforts are made to plant and nurture the trees.

Management Practices

The pruning practices undertaken at present include indiscriminate pruning and result in unsatisfactory size and shape of tree crowns. The lowest branch of the tree should be at a height of not less than 4 m above ground (Poschen, 1986). Pollarding at low heights leads to competition with crops and reduces much of the potential wood and fodder production. Regular pruning from the lower branches is desirable as it allows for the harvest of fuel wood and improves leaf production, the main source of benefit from the tree.

RESEARCH NEEDS

Acacia albida is one of the best known trees of semi-arid Africa. Considerations for additional research include the following:

1. applied research on the protection of young trees and on the cheapest way of establishing plantations;
2. selection and genetic improvement to achieve higher drought resistance, faster growth and higher yields;
3. a general campaign to mobilize and ensure full cooperation of local farmers and herdsmen on a village or community basis for the propagation of *Acacia albida* and to organize the timely supply of seeds and plants to those willing to start their own plantations;
4. because of the multipurpose use of *Acacia albida*, it should be of interest to (a) the agronomist for increasing crop production without the use of expensive mineral fertilizers; (b) the livestock producer for fodder during the dry season, as well as shade; (c) the watershed manager for improvement in soil water-holding capacity and decrease in erosion; (d) the forester for timber uses; and (e) the farmer as an improvement in his living standards without a change in cultural traditions; thus it is in these considerations that *Acacia albida* can be a focal point of the need for coordinated agro-sylvo-pastoral land management program.

CONCLUSION

Acacia albida keeps the promise of the agro forestry concept in the semi-arid zone of Nigeria and holds similar promise in the whole of West Africa (Dancette and Paulain, 1965), Ethiopia (Poschen, 1986), the Sudan (Miehe, 1986) and East Africa (Weber, 1978). The tree is fully complementary to crop and animal production. It increases yields of crops and enhances overall returns from farms. It also supplies fodder and fuel and constitutes a form of savings and security for the rural population simultaneously. The incorporation of the tree does not require any substantial change in farming practices and involves practically no additional cost and labor. The presence of the tree on the farm is not an impediment for intensification and development of rainfed agriculture. *Acacia albida* hold great promise for the development model of agroforestry in the semiarid zone of Nigeria where it can be grown successfully and at the same time is socially and culturally acceptable and provides an ecologically sound solution to our degradation problems.

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Table 1. Mean grain yield of maize and sorghum under and away from Acacia albida Trees in Hararghe highlands, Ethiopia. Source: Poschen, 1966

Crop	No. of samples	Density (plants/ha)		Grain weight/ plant(g)		No. of grains/plant		1,000-grain weight(g)		Yield (t/ha)	
		A[1]	B	A	B	A	B	A	B	A	B
Maize[2,3]	15	33800	31600	9.99**	63.1	328**	221	305	277	3.39**	1.92
Sorghum[2,3]	25	31100	29800	72.0	55.2	174	153	39	36	2.13**	1.57
All plots[3]	27	31100	29900	-		-	-	-	-	2.42**	1.55
Maize[2,3]	Increase	7		58**		49**		10		76**	
Sorghum[2,3]	% A	4		31**		13		9		36*	
All plots[3]	over B	4		-		-		-		36**	

[1] A=under canopy; B=in the open (away from the canopy).
[2] Yield data per ha for maize have been recorded from 13 mixed stands and 2 pure stands of maize and sorghum and extrapolated based on the density of the mixture. Yield data for sorghum are from 12 pure stands and 13 mixed stands with yields extrapolated as for maize above. All yield data at 15% moisture content (dry weight basis).
[3] There were 12 plots of sorghum alone, two of maize alone and 13 of sorghum + maize mixture, significant at 5% level; ** = significant at 1% level.

Table 2. Comparison of maize and sorghum stalk and root weight under and outside the canopy cover of Acacia albida.

Crop	No. of samples	Weight of stalk/plant (g)		Weight of roots/plant (g)		Increase of A compared to B (%)	
		A[1]	B	A	B	stalk wt	root wt
Maize	12	66	53	-	-	24	-
Sorghum	25	145**	97	29**	15	49**	95**

[1] A = under the tree; B = away from the tree;
**significant at 1% level of probability.

Table 3. Fodder value of pods of Acacia albida compared with groundnut haulm and mature native grass.

Crop	Total yield/ha	Digestible protein/kg dry weight	Digestible protein/ha	Net energy /kg dry weight	Net energy /ha
	kg	g	kg	Kcal	Mcal
Acacia albida pods	2500	70	175	1448	3620
Peanut foliage	2000	60	180	725	2256
Mature native grass	4000	10	40	376	1500

Source: Charreau and Nicou, 1971; Boudet and Riveriere, 1967.

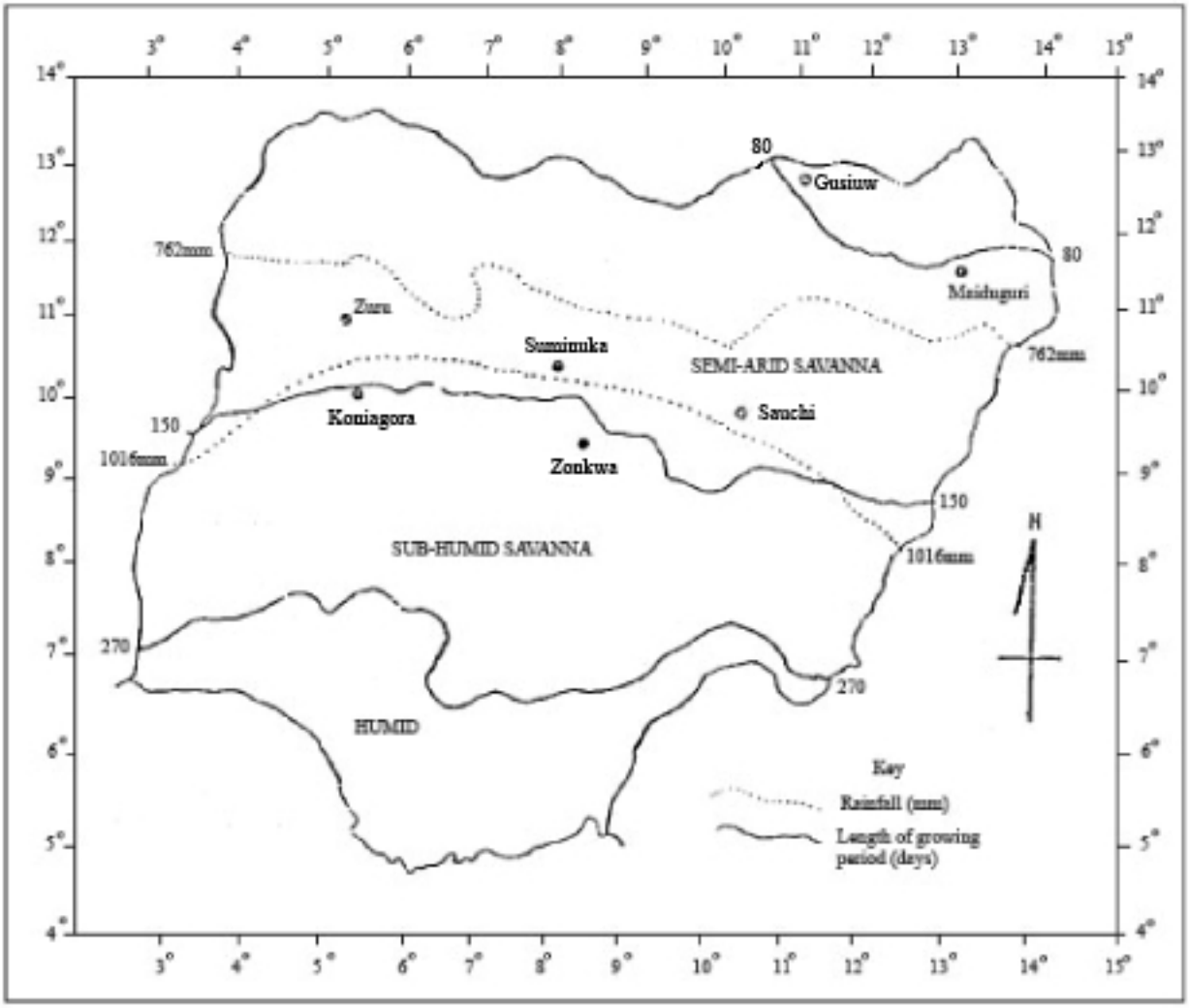

Fig. 1. Map of Nigeria showing the semi-arid region (Ojanuga, 1987).

AGROFORESTRY: A LONG-TERM STRATEGY FOR LAND USE IN THE FOREST ZONE OF CAMEROON

Tonye Jean and Duguma Bahiru[1]

INTRODUCTION

The main land use systems identified in the forest zone of Cameroon are cocoa/food crop, home garden and plantation systems (IRA/ICRAF Report, 1987). Crop production in the area relies on shifting cultivation with fallow periods of two to ten years, during which time the fertility of the soil is restored. The restoration power of the forest fallow is linked to the regrowth of deep-rooted trees and shrubs that recycle plant nutrients and build up soil organic matter (Nye and Greenland, 1965). In addition to restoring soil fertility, the bush fallow provides supplementary food, animal feed, staking materials, firewood and herbal medicine (Okigbo, 1983) Bush fallow is therefore a stable and efficient biological method for soil productivity restoration.

However, the rapid population growth in the forest zone of Cameroon, the scarcity of man-labor and the rigid, privately owned land-tenure system have resulted in a shortening of the fallow periods in the zone Hence, the over-exploitation of land dominated by highly weathered kaolinitic soils is leading to soil degradation and to a decline in crop yield.

Another constraint to crop production in the zone is the lack of capital. Food crop farmers, mostly women have limited income and cannot afford costly inputs such as fertilizers.

Several crop production technologies have been evaluated in the humid and sub-humid tropics to replace or to improve shifting cultivation and the related bush-fallow-slash-and-burn agriculture. One of these technologies is alley cropping. It consists of establishing fast-growing leguminous shrubs or trees that are cut back and kept pruned during the crop growing season to minimize shading and other forms of competition with the companion crops. The system has been demonstrated to reduce the use of nitrogenous fertilizer (Kang et al 1981 and 1985; Wilson and Kang, 1981). Although the management of hedged trees increases labor requirement by about 50%, the system can sustain and increase maize yields by over 60%, resulting in a reasonable benefit-a cost ratio of 1.23 to 1.32 (Ngambeki, 1985).

The crop association is the common practice in the forest zone. The farmer must have most of his food crop grown in his field. Every agricultural technology introduced in the area must therefore take these farming practices into consideration.

THE FOREST ZONE OF CAMEROON

The Central African country of Cameroon is divided into three major ecological zones: the highland; the lowland, high-rainfall forest; and the lowland, low-rainfall zones. The highland area covers mainly Adamaoua, West and North West Provinces. Some of the main agricultural activities in Adamaoua province are cattle raising and the production of sorghum and millet (22,000 tons), maize (43,000 tons) and cassava (80,000 tons), The Western province produces most food crops found in Cameroon; the five main ones are banana (156,000 tons), plantain (127,000 tons), maize (113,000 tons), cassava (88,000 tons) and cocoyam (40,000 tons). In the North West, farmers grow mainly maize (169,000 tons), plantain (159,000 tons), banana (128,000 tons) and cassava (110,000 tons).

The lowland, low-rainfall zone covers provinces of North and Far-North. Fishing, cattle, sheep, poultry and goats raising are the most important farmers' activities. They produce, however, sorghum and millet (400,000 tons for both provinces), groundnut (34,000 tons) and maize (20,000 tons). Rice is produced by parastatal companies.

The lowland, high-rainfall zone covers the provinces of Center, South, East, Littoral and South West. The main characteristic of the zone is the presence of the evergreen and semi-deciduous forest that represents more than 60% of the arable land. Slash-and-burn agriculture and mixed cropping are practiced by almost all small farmers. The four main crops commonly grown are cassava (1,200,000 tons for the four provinces), plantain

[1] Farming Systems Agronomist, IRA - Cameroon, and Forester, ICRAF - Cameroon, respectively

(702,000 tons), maize (63,000 tons) and groundnut (42,000 tons). Cocoyam, taro, yam and banana are also found. All these crops are associated among themselves and among many species of vegetables. Cattle are not raised in the area.

Sheep, goats and chickens are kept in small quantities. Cash crops are cocoa, coffee and palm oil trees. There is a clear division of labor for food crop activities. Land clearing and tree felling are done by men, while hoe plowing, weeding and harvesting are done by women and children. Cocoa and coffee harvest is generally done by the whole family or by the hired labor. Few large mechanized farms owned by foreign or by parastatal companies are found in the area, mainly in Kribi and Tiko (rubber trees), Njombe (banana), Eseka and Dibombari (palm oil trees). These plantations use large quantities of inputs such as fertilizer and pesticides even if the output is not always as expected.

Agricultural production and small farmers' productivity in the lowland, high-rainfall forest zone are mainly hampered by land preparation (clearing and tree felling), low soil fertility, non-availability of inputs such as fertilizers and low farm income. Any agricultural approach aimed at tackling these constraints at farmers' level may be readily adopted by farmers in the zone. One of these approaches is agroforestry.

AGROFORESTRY CONCEPT

Agroforestry is a collective word for all land use systems and practices in which woody perennials are deliberately grown on the same land management unit as crops and/or animals. Agroforestry research, therefore, takes into consideration the social, economic and agronomic parameters intervening in the farmer's life and interactions between and among them. Agroforestry cannot solve all problems farmers in developing countries are facing today. But it is an approach that starts from the "roots" up and can be successfully used in most developing countries' rural projects.

For a long time, a number of rural projects have been executed in many low-income countries. However, most of them could not attain their objectives because more often, farmers' realities are overshadowed by the interest of the financiers as well as that of the policy makers in making the final decision.

An approach that starts by knowing the existing systems, identifying their constraints and proposing technologies to address the constraints and involves nationals from conception to implementation and execution phases of any developmental project as is currently advocated and practiced by agroforestry research methodology can successfully be followed by any rural research or project.

AGROFORESTRY JUSTIFICATION

As stated earlier, crop production and farmer's productivity in the forest zone of Cameroon are hampered by the amount of major plant nutrients such as nitrogen, phosphorus, potassium and the level of organic matter in the soil. Over-exploitation of these soils is due to population pressure and non-availability of inputs such as fertilizers.

Planting trees, including those with multipurpose uses, in the forest zone where tree felling is the most tedious job for farmers may appear absurd and irrelevant not only to farmers but even to most decision makers. On the other hand, however, the primary objective of agroforestry in the forest zone of Cameroon is not to provide fire wood or poles/timbers. Agroforestry is aimed at improving soil fertility through the use of high-value mulch, thereby reducing the level of fertilizer input, stabilizing the shifting cultivation and providing nutritious feed for small stock.

Agroforestry technology such as alley cropping would fulfill the above objectives if implemented objectively. The tree/crop/livestock integration is therefore seen as a long-term strategy for land use in the forest zone of Cameroon.

ALLEY CROPPING EXPERIENCE

Objectives

In 1984, alley cropping trials with *Leuceanea leucocephala* were established in the forest zone of Cameroon, near Yaounde. The objectives of the experiment were a) to evaluate the effects of *Leucaena* pruning on the yield of a maize/groundnut and of a maize/cassava intercrop over 10 years, b) to compare the economic variability of alley cropping versus the traditional system and c) to evaluate farmers' reactions based on an informal survey of participating farmers.

Methodology

Hedges of *Leucaena leucocephala*, var-K-28, were planted in 1984 at 4 m between and 0.25 m within row spacing. The hedge length was 10 m, and an experimental unit was composed every year near the alley cropping plot to simulate the traditional system. Each farmer was considered as a replicate. At the beginning of the project (1984), there were 17 farmers participating. Nearly 50% of them were dropped at the third year because of poor growth of *Leucaena.*

From 1984 to 1986, maize and groundnut were planted between hedges, at the spacing of 2 m x 0.25 m for maize and 0.25 m x 0.25 m for groundnut. From 1987, maize was planted at a distance of 1 m x 0.25 m and cassava at 1 m x 1 m spacing. The same crop densities were used for the traditional system.

Crops were planted two weeks after the first lopping of *Leucaena.* Mulch application and subsequent pruning were carried out twice during the cropping season. All prunings except the woody components harvested from each hedge were applied back to the soil. The length of time spent by workers to perform field operations of clearing, planting, weeding and pruning in a given unit area was recorded for economic analysis.

Three years after the beginning of the project, farmers were informally interviewed to evaluate their reactions about alley cropping. Farmers, both men and women, who had practiced alley cropping for at least two years were asked about the reasons for their acceptance/rejection of the technology. Since the survey was not formal, results from this exercise could give only indications, not strong conclusions.

Results

For the maize/groundnut experiment, labor requirement for alley cropping and traditional system was similar during the first two years and increased by 8 man-days/ha in the third year for the alley cropping (Table 1). This difference was mainly due to the additional pruning labor that became important at the third year.

Maize grain yield in alley cropping increased by 3% from the first to the second year and by 21% from the second to the third year while the yield was constant in traditional system maize by 13% the first year, 15% the second year and 30% the third year (Table 2). These results showed high and sustainable maize yield in alley cropping plots as compared to the traditional system in the field.

Groundnut yields did not show a trend similar to that of maize. Yields from the traditional system tended to be higher than the ones from alley cropping during the second and the third years (Table 3). In alley cropping plots, groundnut yield decreased by 37 and 38% at the second and third years, respectively. This yield decrease was partly due to the reduction in groundnut pod formation. The reduction was 40% in the third year, probably because of the availability of more than enough nitrogen in the soil resulting in excessive groundnut vegetative growth rather than fruiting.

Despite the labor increase and the groundnut yield reduction, most economic parameters favor alley cropping (Table 4). The alley cropping net benefit per hectare in a maize/groundnut experiment is 16% higher than that for the traditional system. A traditional farmer needs 4 man-days/ha more than an alley cropping farmer to produce one ton of food (maize/groundnut).

Out of the 17 farmers interviewed informally after three years, 65% gave a positive reaction as to the adoption of alley cropping with maize/groundnut. A higher percentage of them (29%) would readily adopt alley farming because it improves their productivity by alleviating the land preparation and clearing job. Eighteen percent gave positive reactions because of the good maize yield (Table 5a).

Thirty-five percent of the interviewed farmers had a negative reaction (Table 5b). The reason behind the negative reaction was mainly the increase in labor. The pruning time falls during the weeding period, and some farmers found it difficult to weed and do pruning at the same time.

In the maize/cassava experiment, the first year results (Table 6) showed that alley cropping with *Leucaena* improved maize and cassava yields by 38 and 34%, respectively, as compared to traditional systems.

SUMMARY

The forest zone of Cameroon covers nearly 50% of the country. Food crops are grown by small farmers, and agricultural production is hampered by low soil fertility, non-availability of modern inputs and low farmers' income.

Bush fallow is the only agricultural method used to improve soil fertility. It is agronomically, socially and economically sound.

Agroforestry is a land use system that takes into account the social and economic environment and is aimed at improving crop production of small farmers located in the forest zone.

Alley cropping is one of the potentially suitable agroforestry technologies for the area. Results obtained so far from maize, cassava and groundnut intercrop in *Leucanea* alleys are encouraging.

Although the alley cropping system increases labor demand, economic parameters such as net benefit, return to labor and labor efficiency are higher with alley cropping than with the traditional system.

Feedback from participating farmers indicates that the majority of them will readily adopt alley cropping.

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Table 1. Labor (man-days/ha) for field operations from maize/groundnut itercropped in *Leucaena* alley in the forest zone near Yaounde, Cameroon.

	Traditional			Alley cropping		
Operation	1984	1985	1986	1984	1985	1986
Land clearing	20	20	20	21	16	14
Tree cutting	25	24	26	26	18	20
Packing/burning	7	6	8	3	4	4
Heaping	22	23	22	21	22	23
Crop planting	8	8	7	7	6	8
Tree planting	0	0	0	5	0	0
Pruning (2)	0	0	0	0	16	19
Weeding (2)	36	34	38	34	34	35
Crop harvesting	14	13	15	15	16	17
Total	132	130	136	132	132	140

Table 2. Maize grain yield (tons/ha) from alley cropping with *Leucaena*, From 1984 to 1986, in the forest near Yaounde, Cameroon.

System	1984	1985	1986	Mean
Traditional	2.80	2.80	2.80	2.80
Alley cropping	3.20	3.30	4.00	3.50
Mean	3.00	3.05	3.40	
LSD (0.05)	0.25	0.20	0.40	

Table 3. Groundnut yield (unshelled tons/ha) from alley cropping With *Laucaena* in the forest zone near Yaounde, Cameroon.

System	1984	1985	1986	Mean
Traditional	1.300	1.350	1.300	1.317
Alley cropping	1.350	1.300	1.250	1.300
Mean	1.325	1.325	1.275	
LSD (0.05)	0.030	0.060	0.020	

Table 4. Partial budget from an alley cropping trial with maize and groundnut in the forest zone near Yaounde, Cameroon.

Designation	Traditional	Alley cropping
Crop yield (tons/ha)	4.1	4.8
Labor (man-days/ha)	133	135
Labor efficiency (man-days/ton)	32	28
Benefit ($/ha)	1238	1475

Table 5a. Farmers' feedback for alley cropping with maize and goundnut in the forest zone near Yaounde, Cameroon - positive reaction.

Reasons	No. of farmers	Percentage
No more forest clearing	5	29
Good maize yield	3	18
Good groundnut yield	1	6
Less weeding	1	6
Gives firewood	1	6
Total	11	65

Table 5b. Farmers' feedback for alley cropping with maize and groundnut in the forest zone near Yaounde, Cameroon - negative reaction.

Reasons	No. of farmers	Percentage
Too much work	3	18
Low groundnut yield	2	11
Don't want tree planting	1	6
Total	6	35

Table 6. Maize and cassava yield (tons/ha) for maize/cassava intercrop between *Leucaena* hedges and under traditional system, 1987.

System	Crop yield (tons/ha)	
	Maize	Cassava
Alley cropping	4.060	35
Traditional	2.530	23
Mean	3.295	29
LSD (0.05)	1.035	8

Additional Contributed Papers

A REVIEW OF A.I.D. EXPERIENCE: FARMING SYSTEMS RESEARCH & EXTENSION (FSR/E) PROJECTS-1975-1987[1]

Kerry J. Byrnes[2]

ABSTRACT

This paper summarizes a Center for Development Information and Evaluation (CDIE) study of Agency for International Development (A.I.D.) experience in implementing farming systems research and extension (FSR/E) projects. Drawing on evaluation reports, case studies were prepared on 12 A.I.D.-funded FSR/E projects implemented between 1975 and 1987: seven in Africa, two in Asia and three in Latin America and the Caribbean. Analysis of the case studies suggested that these FSR/E projects achieved mixed impact, where impact is defined in terms of technology development and transfer and institutionalization of FSR/E. These general categories of factors were found to have impeded project implementation and impact: core, operational and generic constraints. The study identifies lessons learned that need to be taken into account in the design, implementation and evaluation of projects having an FSR/E component. The study contributes to the ongoing discussion about FSR/E's potential as a strategy to strengthen technology development and transfer in the developing countries.

SUMMARY[3]

A.I.D.-funded Farming Systems Research and Extension (FSR/E) projects achieved mixed impact on technology development and transfer and institutionalization of FSR/E. FSR/E projects have provided research and extension personnel with opportunities for training and field experience in FSR/E. But FSR/E has yet to be effectively incorporated into technology development and transfer systems to an extent that would permit FSR/E to begin to achieve the impact on agricultural production assumed in project designs.

Key constraints have included the lack of a problem-solving approach; effective collaboration across disciplines; links with extension; consensus on methodology for FSR/E; stakeholder understanding of FSR/E; agricultural policy and strategy defining the FSR/E's role in research and extension; staffing of projects with trained manpower; and government funding to meet recurrent costs.

While the FSR/E concept often has not been well understood by project implementers or A.I.D. management, projects that seek to strengthen agricultural technology development and transfer can benefit by a more effective utilization of the FSR/E concept. The lessons learned from this CDIE review can serve to improve design, implementation and evaluation of agricultural projects having a technology development and transfer component.

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[1] This is an abbreviated version of a paper of the same title presented at the 8th Annual Farming Systems Research/Extension Symposium, October 9-12, 1988, Center for Continuing Education, Fayetteville, Arkansas. The paper is an excerpt from a draft report of the same title being revised for publication by A.I.D.'s Center for Development Information and Evaluation (CDIE). The views and interpretations expressed are those of the author and should not be attributed to A.I.D. or CDIE. The author appreciates the contributions made by Tim Frankenberger of the FSR/E Network Steering Committee; A.I.D. officials, particularly Joan Atherton, Roberto Castro, Cal Martin, Wendell Morse and Michael Yates; CDIE colleagues, particularly Siew Tuan Chew, Joe Lieberson and Annette Binnendijk; and Francis C. Byrnes of Winrock International.

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[3] This paper is based on a review of evaluations and case studies of 12 farming systems research and extension (FSR/E) projects funded by the Agency for International Development (A.I.D.) between 1975 and 1987, as follows:

Botswana Agricultural Technology Improvement (633-0221)
Gambia Mixed Farming Resources Management (635-0203)
Lesotho Farming Systems Research (632-0065)
Malawi Agricultural Research (612-0202)
Senegal Agricultural Research and Planning (685-0223)
Tanzania Farming Systems Research (621-0156)
Zambia Agricultural Research and Extension (611-0201)
Nepal Agricultural Research and Production (367-0149)
Philippines Farming Systems Development (492-0356)
Guatemala Food Productivity & Nutrition Improvement (520-0232)
Honduras Agricultural Research (522-0139)
ROCAP Small Farm Production Systems (596-0083)

BACKGROUND OF THE PROBLEM

Farming Systems Research and Extension (FSR/E) gained momentum during the 1970s as the perception grew that the conventional approach to agricultural research and extension did not work well in most developing countries. Typically, commodity or discipline research, based at experiment stations, followed a "top-down" technology development and transfer model. Scientists proceeded without considering the actual problems farmers faced. Lacking knowledge and understanding of the management conditions under which small farmers operate, many researchers erroneously assumed that smallholder farming systems are static; that small farmers reject technologies out of sheer ignorance or traditionalism; that small farmers seek to maximize yield and profit; and that commodity-oriented research can generate broad-based technologies relevant to smallholder farming systems. As a result, "improved" technologies frequently failed to attract farmers to adopt them.

A.I.D.'s ASSISTANCE APPROACH

A.I.D. responded by committing project funds to a new approach to agricultural research known as farming systems research and extension (FSR/E). Since 1975, more than 75 A.I.D. agricultural projects have included some form of FSR/E.

FSR/E projects seek through on-farm research and extension to test, adapt, integrate and disseminate new technologies for farmer adoption. Technology development is based on knowledge of the whole farming system, and technology evaluation takes into account technical criteria (e.g., yield improvement) as well as the farm family's socioeconomic circumstances. Further, knowledge of farming systems is used to help define on-station and on-farm research agendas, with the expectation of generating productivity- and income-increasing technologies more acceptable to smallholder farmers.

Viewing the farm as a system, FSR/E practitioners focus on farm family attributes-goals, preferences, skills, resources, production activities and management practices; interdependencies among system components that family members control; and the interaction of these components with physical, biological and socioeconomic factors not under the farmer's control.

FSR/E's CORE CHARACTERISTICS

FSR/E entails the blending and sequencing of nine core characteristics.

1. FSR/E is farmer-oriented. FSR/E targets small-farm families as the client group for research and identifies technology relevant to this group's management conditions by identifying these conditions before proposing technological solutions and by adapting technologies to local circumstances and needs.
2. FSR/E involves the client group as participants in the research and extension process. FSR/E practitioners involve and work with client group members to design, implement and evaluate research and extension activities.
3. FSR/E recognizes the locational specificity of technical and human factors. FSR/E practitioners identify client groups of farmers that are relatively homogeneous in terms of agro-climatic, socioeconomic and other factors.
4. FSR/E is a problem-solving approach. FSR/E practitioners identify the constraints to increased farm productivity and income. The primary concern is to help farmers solve problems.
5. FSR/E is systems-oriented. FSR/E views the total farm as a system of natural and human components and focuses on specific production subsystems to evaluate the potential for introducing improved technology in one or more subsystems and the impact of this technology on the farming system as a whole.
6. FSR/E is interdisciplinary. Collaboration among agricultural and social scientists facilitates (1) identification of the conditions under which small farmers operate; (2) diagnosis of constraints; and (3) design, conduct and evaluation of research and extension activities aimed at developing and introducing improved technologies suitable to the client group of farmers.
7. FSR/E complements, not replaces, conventional commodity and discipline research. FSR/E adapts technologies and management strategies from discipline and commodity research to the farmers' agro-climatic environment and socioeconomic circumstances.
8. FSR/E tests technologies in on-farm trials. On-farm collaboration between farmers and FSR/E practitioners provides each with a deeper understanding of the farming system and the farmer's decision

making criteria and allows for development of technology under farm-level environmental and management conditions.

9. FSR/E provides feedback for shaping research priorities and agricultural policies, FSR/E, a dynamic and iterative process, provides information on farmer goals, needs, priorities and criteria for evaluating technologies and on how new technologies perform under farm conditions.

If any core characteristic is missing or weak, a technology development and transfer methodology really does not constitute FSR/E, and its practitioners really are not doing FSR/E.

IMPACT

Assessing FSR/E project impact on technology development and transfer is confounded by three factors:

- the relative contributions of conventional agricultural research and FSR/E are not readily separable-they are complementary;
- technology adoption depends upon factors not under the control of FSR/E teams--e.g., physical infrastructure, policy environment and agri-support institutions (e.g., credit);
- because FSR/E encompasses technological development and institutional change, significant results may be achievable only in a longer time frame (e.g., 10-25 years).

Beyond these factors, unrealistic expectations may have been created about how quickly or the extent to which FSR/E could by itself increase the productivity of a country's agriculture For example, FSR/E project "logical frameworks" often assumed unrealistic goals and objectives for farm-level impact that realistically could not be achieved within the typical A.I.D. project time frame. Or project designs erroneously assumed that on-shelf technologies were available for on-farm testing and adaptation to a variable agro-ecological environment.

While evaluations and case studies of 12 A.I.D.-funded FSR/E projects provided insufficient data to assess direct beneficiary impact (e.g, farmer income), they indicated some success in training development personnel in FSR/E and providing them with practical opportunities to gain field experience in FSR/E.

Participation in FSR/E not only changed researchers' attitudes about small farmers as the clients of research but also influenced how researchers defined research problems, set research priorities and carried out problem-oriented research on farms. Such changes have increased the likelihood of research and extension focusing on farmer-relevant problems.

Despite some successes, the period of time needed to institutionalize FSR/E is probably 10 to 15 years or more. Most FSR/E projects, with a life of project funding of five years or less, did not achieve the impact on technology development and transfer or institutionalization of FSR/E that had been assumed in these projects' designs (logical frameworks).

FINDINGS

The gap between actual and expected impact was not associated with any shortcoming in the FSR/E concept per se but rather with the failure of FSR/E projects to address core, operational and generic constraints to implementing the FSR/E concept.

Core Constraints

During the early years of FSR/E projects, the "farming systems" concept was neither well defined nor widely understood. FSR/E project implementers, trained in conventional disciplines, were not well versed in the FSR/E concept, lacked field experience with it and were not accustomed to working in an interdisciplinary manner to solve farmer-relevant problems.

There were few bona fide FSR/E practitioners; within A.I.D. probably even fewer understood the core characteristics required for technically-sound FSR/E. As a result of confusion and uncertainty about what FSR/E is, should or could be, many so-called FSR/E projects were not doing FSR/E. Indeed, the most frequent core constraints, appearing in at least 7 of the 12 projects, were lack of a problem-solving orientation and lack of an interdisciplinary approach.

Operational Constraints

FSR/E projects often did not address operational constraints to implementation. At least 7 of the 12 projects suffered from lack of consensus on FSR/E methodology, agricultural research policy or strategy defining FSR/E's role, links with extension and stakeholder understanding of FSR/E.

A major constraint was the lack of consensus among technical assistance, counterpart and USAID personnel
on how to do FSR/E. Also problematic was conducting FSR/E in settings where agricultural policy and strategy did not define FSR/E's role relative to research and extension and where FSR/E was perceived as competing for scarce resources. Doing FSR/E also was hampered by failures in ensuring (1) that stakeholders (managers of research and extension) understood FSR/E's benefits and requirements; (2) that FSR/E practitioners could analyze and interpret the data collected; and (3) that extension was effectively linked with research as a source of technology.

In short, A.I.D. introduced FSR/E without realizing that FSR/E cannot make an impact unless a broader set of conditions than are implied by FSR/E's core characteristics alone also is met.

Generic Constraints

A generic constraint is present when FSR/E implementation is impeded by problems that can arise in any A.I.D.-funded project, regardless of the project's technical focus. The two most frequent generic constraints, appearing in at least 7 of the 12 projects, were lack of staffing with trained manpower and lack of government funding to meet recurrent costs.

All too frequently, A.I.D. attempted to implement FSR/E projects where adequately trained manpower (e.g., to fill counterpart staff positions) and funding for recurrent costs (e.g., fuel for project vehicles) were not or could not be provided.

Other areas in which problems were encountered included project management structure, management of training and management of technical assistance (TA). In the latter area, problems included delays in the arrival of TA personnel, turnover of TA personnel, lack of TA experience in FSR/E and allocation of TA time to project administration rather than to FSR/E.

LESSONS LEARNED

This review of 12 A.I.D.-funded FSR/E projects and a recent A.I.D./S&T/Agriculture-funded "results inventory" of FSR/E projects suggests the following as the key "lessons learned."

The Farmer in FSR/E

In FSR/E, the farmer plays a central role in technology development and transfer—one of an active collaborator, not just a passive observer or receiver. Yet FSR/E practitioners often have had difficulty implementing this concept because highly centralized and vertically structured research and extension systems are geared to respond to top-down lines of authority rather than to farmer-identified needs and priorities.

Farming in FSR/E

FSR/E projects have tended to focus on the food crops raised by subsistence farmers, with little attention to the other commodities these farmers produce for sale. Several evaluations raised the issue of whether FSR/E should place greater emphasis on cash crop technologies to assist farmers to produce and market higher-valued crops or animals.

Systems in FSR/E

FSR/E practitioners often have not gone beyond lip service to the concept of the farm family household as a system of natural and human components that must be understood if FSR/E is to influence agricultural income. Some FSR/E practitioners spent so much time studying the farm as a "system" that they never got around to testing potential technologies or institutional changes to overcome constraints. Others focused on one crop (e.g., maize) but failed to examine the crop's interrelationships with other system components (e.g., livestock).

Given research mandates, FSR/E practitioners often have focused on improving production technology, primarily for crops, as the end rather than a means. If increased farm family income is not built into the design of FSR/E, the chances are increased that FSR/E will not focus on the farm and farm family as a system, thereby losing the systems concept as FSR/E's guiding rationale.

Research in FSR/E

The emphasis in FSR/E on research aimed at developing technologies to relax production constraints often has resulted in failure of FSR/E practitioners to address institutional constraints to adoption of the technologies being developed. Such technologies frequently cannot be adopted by farmers unless they also have access to agri-support services (e.g., credit, production inputs, markets). FSR/E practitioners, particularly social scientists, need to place greater research attention on identifying means to remove or relax institutional constraints that impede farmer access to agri-support services.

Extension in FSR/E

Each FSR/E project reviewed was located in a research organization, thereby raising the problem of how FSR would be linked with extension. Many FSR/E projects viewed the "farming systems approach" as a research strategy, not as a strategy to integrate research and extension.

The Link ("/") in FSR/E

Improved agricultural technologies are rarely transferable directly from research to extension. But FSR/E teams can play an important role in linking research and extension, working with farmers and extension to test and adapt technologies derived from research and with researchers to provide feedback to establish research priorities. However, without an adequate incentive structure, it will be difficult to link research and extension into a productive partnership.

Methodology of FSR/E

A key contribution of A.I.D.-funded FSR/E projects has been provision of opportunity for field-level development, testing and adaptation of FSR/E methodologies. However, FSR/E's impact on technology development and transfer will be negligible until research and extension personnel work out a joint strategy to institutionalize FSR/E methodology in research and extension programs.

Current Status of FSR/E in A.I.D.

Many of FSR/E's core characteristics (e.g., on-farm trials) are now designed almost routinely into A.I.D.-funded agricultural projects. Further, an A.I.D.-sponsored survey of USAID Missions found that these Missions place a high priority on training in FSR/E, institutionalization of FSR/E and technology transfer. These trends indicate that FSR/E is playing a role in Agency-funded projects aimed at strengthening agricultural research and extension.

There Are No Panaceas

As A.I.D. turns its attention to "new" problems (e.g., sustainability of natural resources), the Agency should refrain from assuming there are "magic bullets" that will quickly lead to smallholder development in LDCs. Achieving LDC smallholder development objectives will best be served by systematically addressing the problems of agricultural research and extension on a sustained, long-term basis.

OUTSTANDING ISSUES

Three outstanding issues merit consideration: (1) sustainability of FSR/E, (2) sustainability of natural resources and (3) project orientation to FSR/E.

Sustainability of FSR/E

FSR/E cannot be institutionalized without developing an ability to meet recurrent costs. This is impeded where government research and extension budgets leave few resources for carrying out activities on farms (e.g., on-farm trials). External support for FSR/E needs to provide incentives for public and private funding of research and extension and ensure that host country research and extension organizations develop a capability to assume FSR/E's recurrent costs.

Sustainability of Natural Resources

Those concerned with "new" issues (e.g., sustainability) may fail to see the role that FSR/E can play in natural resources, agroforestry and agricultural projects. Properly implemented FSR/E could offer an excellent vehicle for addressing the sustainability of the natural resource base. The challenge is to ensure that

sustainability initiatives involving FSR/E's core characteristics are not undermined by the same constraints (core, operational and generic) that plagued past FSR/E projects. Those developing a "sustainable agriculture" agenda should ensure that the constraints impeding FSR/E projects do not come back to haunt new projects aimed at supporting a "transition to sustainable agriculture."

Project Orientation to FSR/E

FSR/E would not be where it is today in many countries without the support that A.I.D. and other donors provided FSR/E projects. However, implementation of FSR/E has not been facilitated by an assistance mode (i.e., the project) that provides support for only a 3-5 year span; indeed, these results were, to a certain extent, "predetermined" by the short life span of the projects reviewed. Success in research and institutional development requires a longer time frame, and this is no less true in FSR/E.

FSR/E is not a substitute for conventional research but can be instrumental in accelerating the speed with which technologies are developed and transferred. But this process is not aided by a short-term orientation to agricultural research in general or FSR/E in particular. Support needs to be sustained over the long-term (25-30 years).

The challenge for future A.I.D.-funded agricultural projects is to address the constraints to FSR/E more effectively. A.I.D. can strengthen the contribution of agricultural research and extension to technology development and transfer by ensuring:

- that FSR/E's nine core characteristics are systematically built into technology development and transfer methodologies;
- that agricultural research and extension projects provide a means to remove or relax the operational constraints that can impede implementation of FSR/E; and
- that project assistance to relax core and operational constraints to FSR/E is not undermined by generic constraints.

The problems encountered in implementing the FSR/E concept in FSR/E projects did not result from any shortcomings in the FSR/E concept but rather from limited knowledge and understanding of the requirements for implementing this concept. FSR/E, properly implemented, can strengthen the technology development and transfer capability of agricultural research and extension systems.

The challenge is to integrate FSR/E into technology development and transfer methods and not permit them to be undermined by the core, operational and generic constraints identified here as having impeded FSR/E's implementation and institutionalization in developing country research and extension systems. FSR/E explicitly recognizes the need for links among farmers, extension workers and researchers and defines the essential conditions (core characteristics) for increasing the impact of donor, government and private investment in agricultural research and extension. However, this impact cannot be fully realized unless development assistance also addresses the various operational constraints that can impede institutionalization of FSR/E.

This will require a long-term commitment (15-25 years) by A.I.D. to institutionalize technology development and transfer systems responsive to the problems faced by developing country smallholder farmers. If A.I.D. has the vision and the means, the Agency's continued support for institutionalizing FSR/E can play a crucial role in increasing the productivity and income-earning capability of small farmer agriculture throughout the LDCs.

POSSIBLE FUTURE DIRECTIONS FOR AID ACTIVITY IN FARMING SYSTEMS RESEARCH; A CONCEPT PAPER

James A. Chapman, Albert. L. (Scaff) Brown and Roberto J. Castro[1]

INTRODUCTION

Since September 1982, the Office of Agriculture within AID'S Bureau for Science and Technology has supported farming systems development in developing countries by means of technical assistance, training and networking provided through the Farming Systems Support Project (FSSP). AID terminated support of FSSP on December 31, 1987, for reasons outlined in the End-of-Project Evaluation and other documents. However, the potential importance of farming systems work for agricultural development in general, and for the small-farm sector in particular, continues to be recognized.

The purpose of this document is to initiate and stimulate discussion regarding the future direction and focus of efforts by AID and other donors to support work in farming systems research and development. It contains a brief analysis of the historical reasons why the farming systems approach came about, an examination of possible areas in which future work in farming systems could concentrate, a discussion of possible options that AID could use to channel future support and recommendations regarding priority activities for the immediate future and the medium term.

THE EVOLUTION OF THE FARMING SYSTEMS APPROACH: AN HISTORICAL SKETCH

The farming systems approach to agricultural development came into existence in response to the inability or unwillingness of certain types of farmers-particularly small, limited-resource farmers--to adopt new agricultural technology emanating from the universities, the international agricultural research centers and the private sector.

For many years, development specialists believed that farmers did not adopt technology because they were perceived as being backward and uneducated, possessing a traditional mentality that rejected change. This concept gradually changed as professionals undertaking Geld research in developing countries began to communicate directly with small farmers, discovering that resistance to technology adoption was due not to mentality, but rather to the myriad of constraints and disincentives facing farmers. Principal factors limiting adoption were lack of access to capital inputs, product and factor price levels that negated profitability of new technology, lack of or difficult access to markets or enterprise patterns that responded to the needs of farmers for food, off-farm employment or livestock, all of which did not facilitate the use of technology designed to be applied to a monocrop situation. As further evidence, Theodore Schultz, in his landmark book *Transforming Traditional Agriculture*, found small farmers to be relatively efficient producers from an economic standpoint in allocating their scarce available resources to alternative productive activities off the farm as well as on.

Why was there a lack of "appropriate technology"? One reason was the evolution of the structure of agriculture in the developed world, especially in the United States. Until the 1940s, the U.S. agricultural production sector was characterized by small family farms, which were served by a land-grant research and extension system composed of professionals from farm backgrounds in tune with the needs and circumstances of their clientele, the farmers.

Over time, the structure of U.S. agriculture evolved, spurred on at least in part by the invention of labor-saving technology enabling a single farmer to productively farm larger and larger areas of land. Unfavorable cost-price relationships meant that farm size had to increase in order to generate adequate incomes. "Get big or get out" was and continues to be the theme of the day. The rapid pace of industrialization and the development of the service sector provided the mechanism for absorbing much of the displaced farm labor. Farms got bigger and controlled more resources.

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As part of this process, the land-grant system also evolved to better serve the needs of a new clientele-larger farm businesses with substantial resource bases. In order to address the more precise technological needs of the new structure, universities became more specialized, divided into disciplines and sub disciplines, to a great extent losing their multidisciplinary perspective and interest in the farm-household. Farm management, the area in which the various disciplines were integrated into a whole-farm perspective, assumed reduced attention and importance. Teaching of the subject was limited mainly to a few courses contained in the curriculum of agricultural economics departments.

Another contributing factor was the general direction of technological change, with a definite bias toward innovations resulting in marketable, patentable products rather than more general techniques and cultural practices whose benefits are not necessarily capturable by the innovator, Although the literature is filled with information about the functioning and contributions of the land grant system, it appears that the private sector has had a greater role than realized in shaping the patterns of technological change in world agriculture through the development and export of technology embedded in inputs and machinery.

The methodology of agricultural research was transferred to the developing countries through the education and training of LDC professionals in U.S. universities who later returned to positions of leadership in their own countries and via programs through which U.S. universities helped organize and develop faculties of LDC universities. Thus, the same bias toward larger farmers with greater access to resources was transferred to the LDC research establishment.

Perhaps more important than education regarding research organization and methodology was the transfer to LDCs of the technology itself, for the most part contained in hybrid seeds, chemical inputs and machinery and implements. It facilitated concentration of agricultural production on larger units while at the same time lowering overall labor requirements. In contrast to the U.S. situation, displaced labor could not be absorbed by the usually underdeveloped industrial sector. Significant portions of the population settled on hillsides and marginal lands less well suited for agriculture.

Small farmers in LDCs comprise a large percentage of the rural population, and their production impacts considerably on national food supplies, especially with respect to staple food crops such as rice, corn and beans. Thus, a definite demand, more latent than expressed, existed for the development of the farming systems approach.

The farming systems approach was developed and refined over time through trial-and-error field experience of an initially small group of researchers who developed a better understanding of the constraints faced by small farmers in the developing countries of Asia, Africa and Latin America. Among the better known developers and proponents of the approach were Collinson and Norman in Africa; Hildebrand and Hart in Latin America; and Bradfield, Harwood and Zandstra in Asia. These original implementers came from diverse disciplinary back- grounds, mainly agronomy and agricultural economics, and were able to recognize the contribution to problem solving that various disciplines could make. Apparently, there was minimal communication among the researchers from different continents and- with the exception of Asia-within continents in the early stages, so several researchers developed similar conclusions and strategies independently during roughly the same time period.

Problems related to the approach began when, in a pattern similar to other short-lived approaches to agricultural development (e.g., integrated rural development, public institution building, agricultural sector modeling and, most recently, non-traditional agricultural exports), it became a fad among the international donor community. The notion and concepts surrounding farming systems research, or FSR as it was more commonly known, were accepted and adopted by members of the broader academic and research community who had not really participated in its development. They did, however, help "sell" the idea to the donor community, and soon farming systems came to be viewed by many as a panacea rather than simply an alternative approach to development and transfer of technology adapted to the needs of small farmers. AID commissioned a survey on farming systems research and development work worldwide which, when published, helped promote the concept (Shaner et al., 1981).

A major problem early on was the lack of a uniform definition of what farming systems was and was not. Confusing terminology proliferated, and many people assigned their own definitions, thereby adding to the confusion. The lack of clear definition and uniformity of terms meant that some projects and programs were doing farming systems type work without acknowledging the label, while others were doing something else and calling it farming systems. The term proliferated in the development of new AID projects, mainly because project developers believed that using that label would assure rapid project approval. During the early 1980s, the number of AID-financed farming systems projects or projects with farming systems components being implemented worldwide increased significantly to the point that the majority of countries in which AID works now have or have had farming systems projects. A survey conducted by FSSP in 1985 indicated that there were

some 250 long-term projects worldwide carrying out farming systems work. Since 1978, AID has funded 76 bilateral, regional and centrally-funded projects containing either a farming systems orientation or clearly focused on farming systems work-45 in Africa, 19 in Asia/Near East, 10 in Latin America and the Caribbean and FSSP with (arguably) a worldwide focus. Furthermore, new projects with farming systems components are continuing to be developed and implemented.

While the number of farming systems projects increased rapidly during the early 1980s, the supply of qualified technical assistance providers could not keep up with the demand. There were few well-trained professionals with real field experience who were capable and available to provide the quantity and quality of technical assistance necessary to establish and facilitate the integration of farming systems research methodology into LDC research and extension systems. Given the short supply of experienced practitioners, the quality of technical assistance provided to projects has been variable at best. Poor project implementation performance on a number of projects has contributed to a downgrading of the approach in the eyes of many development professionals and AID project managers.

Given the nature of events that had occurred, it becomes clear why donor support for farming systems work has fallen off. Initially, high expectations were stimulated because farming systems appeared to be something new, it involved potential changes that would benefit everybody or at least hurt nobody, and it focused on directly helping the poorer segments of the rural population. At the same time, there was a general misconception regarding the level of development of the state of the art in farming systems implementation, as well as a misunderstanding regarding the length of time required to institutionalize the approach and begin to develop technologies appropriate for adoption by limited resource farmers. Nevertheless, a vocal minority of university faculty members and the small group of professionals with actual field experience eagerly jumped on the bandwagon. Many of the senior university faculty viewed farming systems as a reinvention of an old wheel (farm management), resented the notoriety that farming systems was getting and for the most part did not participate in the projects and networks. Looking back, this was unfortunate, as input from those with a broader historical perspective perhaps could have benefited the emerging farming systems methodologies.

THE ESSENCE OF THE FARMING SYSTEMS APPROACH

The essence of the farming systems approach is not in the various methodologies and points of view that have arisen. Rather, it is in the basic client orientation that is inherent in the philosophy of the approach, if not always evident in how it is practiced. A multidisciplinary group of researchers first examines a system and its particular set of surrounding socioeconomic and physical-biological circumstances and then develops a diagnosis as to where problems lie and offers potential solutions to problems that exist. Based on the diagnosis, a research strategy is designed to help alleviate key constraints, usually focused on a combination of crop and/or animal enterprises. Experiments are designed and carried out on a number of representative farmers' fields, with the efforts hopefully resulting in the development of new practices that may be easily adopted by local farmers facing similar circumstances. The literature is cluttered with a myriad of terms that, for the most part, represent minor variations around this central basic theme.

A primary contribution of farming systems research is that it fills a gap in the more traditional agricultural research process by providing closer linkages between researchers and farmers. It allows an adjustment of the process from "top-down/researcher-driven/supply-push" ways typical of the colonial heritage of many developing countries toward "system-based/farmer-driven/demand-pull" methods. Furthermore, with a greater portion of work taking place in rural communities and farmers' fields, there are major opportunities for linkages between research and extension functions, thereby providing continuity between the technology development and diffusion processes.

Because the diagnosis phase identifies technical and resource problems facing farm families and communities, the approach is potentially a powerful tool in two other roles: the setting of priorities for applied and basic research; and the identification of policy issues and requirements for facilitating the adoption of emerging technology. These interfaces between farm technology and agricultural sector policy are increasingly vital to raising rural productivity and incomes.

It should be clear by now that farming systems research is not a panacea or solution to all problems. It does, however, have its place within the technology development and transfer continuum between basic commodity research and transfer of proven technology to farmers. It consists not only of activities but also of channels of information between the developers of technology and those who use it. Undertaken correctly, farming systems workers provide the linkage that is often missing between research and extension by combining elements of both in an interactive and iterative mode.

THE FUTURE OF THE FARMING SYSTEMS APPROACH

At this time, it is inappropriate to pass judgment on the overall effectiveness of farming systems work worldwide, since many of the projects are ongoing and, indeed, some are just beginning. What does seem clear is the realization that significant progress in technology development and transfer requires a longer time frame than is usually conceded in a project-type framework. Thus, farming systems projects tend to be downgraded because tangible results in terms of increased productivity and incomes may not be evident two or even four years into the life of a project. What farming systems does offer is a process that is philosophically and logically appealing but with no guarantee of the end result-which often depends largely upon factors beyond the control of farming systems practitioners.

Despite the problems with performance and unrealized expectations, there still exists a substantial group of people who believe in the basic validity of the farming systems approach, consisting of a number of faculty members of U.S. universities (mainly social scientists) employed at the IARCs who have incorporated aspects of the approach into their training programs and standard operating procedures and professionals in developing countries working in national research and extension programs. Moreover, there are still a number of ongoing projects and programs with farming systems components, and significant progress has been made in training, networking and methodology development by FSSP, IDRC, CIMMYT, IRRI and others. A few of the methods commonly associated with farming systems, especially the rapid rural appraisal or "sondeo, " have been and are being adopted by other types of development efforts, such as the analysis of agricultural markets. In a sense, they have taken on a life of their own but are properly attributable to work in farming systems. It is clear that, whether or not farming systems survives as a methodology per se, its influence on agricultural development will be felt for a long time to come.

Several questions arise regarding the future of farming systems and the appropriate role of the approach in agricultural development. Should support of farming systems work be withdrawn? Are the networks and programs established strong enough to stand on their own? If further assistance is required, what should the nature of this assistance be? What are the plans of donors other than AID? Given current budget and manpower constraints, what is the capacity of AID to provide financial and technical support for farming systems? Should there be a "bridge" with the existing project while a new strategy comes on line?

The balance of this paper will address some of those questions, presenting analyses, viewpoints, alternatives and recommendations as to AID's future participation and focus in support of farming systems work.

A CONCEPTUAL FRAMEWORK FOR THE FUTURE DEVELOPMENT OF FARMING SYSTEMS METHODOLOGIES

In November 1987, as part of the process of review of S&T/AGR activities in support of farming systems work, an advisory panel of agricultural development professionals was selected and convened at the offices of Chemonics International in Washington, D.C. The meetings lasted two days and consisted of a review of the draft Final Evaluation of the Farming Systems Support Project (FSSP) and brainstorming as to the future activities in farming systems which S&T/AGR could consider funding in a follow-on to FSSP. Participating in the discussions as panelists were:

Albert "Scaff' Brown - agricultural development expert, Chemonics team leader and former chief of the Rural Development Office of AID's Latin America Bureau;

James Chapman - agricultural economist, Chemonics team member and farming systems practitioner with experience in Latin America and Asia-,

Michael Collinson - agricultural economist, science advisor for the Consultative Group on International Agricultural Research (CGIAR) and farming systems expert with 20 years of experience in Africa;

Hubert Zandstra - agronomist, director for agriculture, food and nutrition of the International Development Research Centre (IDRC) and a farming systems expert with broad experience in Asia and Latin America;

Lane Holdcroft - agricultural economist, independent consultant and former head of the Technical Resources office of the Africa Bureau;

Michael Yates - rural sociologist, AID/S&T/RD, formerly a farming systems practitioner for CIMMYT in Haiti;

Calvin Martin - agricultural research specialist, technical advisor to the Technical Resources Office of AID's Africa Bureau; and

Roberto Castro - agricultural economist with S&T/AGR and project officer of FSSP.

The results of the panel discussions were put into a matrix format and presented to several practitioners and support entity representatives at the Farming Systems Symposium held at the University of Arkansas in October 1987. They were also presented to the members of the Technical Subcommittee for Agricultural Research and Extension of the AID Agricultural Sector Council.

Figure 1 schematically presents a framework for looking at processes and activities that either reinforce current farming systems work or look toward the future as to where increased attention should be focused as part of farming systems-type efforts.

Processes

The left-hand column of the matrix details the sequence to steps usually implemented in the development of an activity from recognition of need and identification of the problems that need to be addressed through to the institutionalization of the activity in national agricultural research and extension systems. The process is sequential, but not rigidly so. Not all the steps necessarily need to be included, the order may change according to circumstances, and successive iterations of previous steps may need to occur before problems are effectively solved or dealt with. A brief explanation follows of each of the steps.

Sequence of Steps.

1) Problem Identification. A need to address a specific problem area through the development and implementation of one or more specific activities is identified.
2) Project/Program Development. Based on the identification of a problem area, a specific project or program is designed to correct the problem or advance the state of the art.
3) Networking. Contacts are made among practitioners in different areas of a country or region to trade information regarding experiences in addressing or solving the particular problem. This may involve written or verbal communication, usually through newsletters, technical papers and seminars.
4) Synthesis of Experience. After a period of time has transpired, an analysis is carried out of the experiences of several groups or projects in dealing with the problems. Lessons learned are synthesized.
5) Methodology Development. Based on experience over time, a methodology or set of recommended procedures is developed to deal with the problem. The methodology may be written up in a handbook or incorporated into sets of training materials.
6) Training and Maintenance. Once the methodology for addressing a problem is well developed, it is ready for transfer to those individuals or groups who can benefit from it in order to more effectively carry out their work. As new experience is gained and the ability to deal with problems improved, the training materials and strategies need to be revised to incorporate the new knowledge.
7) Institutionalization. The resolution of certain problems may lie within the mandate of public or private institutions. The issue needs to be addressed regarding how best to incorporate new modes of behavior so that identified problems are adequately addressed on a routine basis.

Traditional Farming Systems Research as an Example. As an example of the process, consider the development of what is commonly thought of as traditional farming systems research, the process of undertaking research on farmers' fields and extending the results.

The problem was the low productivity of small, limited-resource farms and the non-adoption of available new technology developed on the research stations.

The recognition of this problem and the desire to solve it led to the creation of projects and programs such as the Cropping Systems Program at IRRI, the Puebla Project in Mexico, the Caqueza Project, the CATIE Farming Systems Project and others.

Some projects and programs established communications networks in order to provide mutual technical assistance and share experiences. Notable in this area was the establishment of the Asian Cropping Systems Network by IRRI's Cropping Systems Program in the mid-1970s. More recently, the FSSP has made significant efforts at networking, utilizing newsletters, symposia and providing support to WAFSRN in West Africa.

As an outgrowth of individual and collective experience in Asia, Africa and Latin America, an AID-commissioned study (Shaner et al. 1981) was published in 1981 that synthesized the experiences with farming systems work up to that time.

The methodologies of farming systems work were further developed and refined by the IARCs with farming systems programs (especially CIMMYT and IRRI) and individual field practitioners. FSSP prepared and revised training manuals on on-farm experimental design and analysis and diagnosis of farming systems.

Training in farming systems research and extension has been undertaken extensively through bilateral farming systems projects and formal courses planned and executed by FSSP in West Africa and Latin America, by CIMMYT in East Africa and by the University of Hawaii, IRRI and others in Asia.

Principals and practices of the farming systems approach are currently in the process of being institutionalized through training and field practice. How best to incorporate farming systems work into the standard operating procedures of national research and extension institutions is still being tried and tested. ISNAR is in the process of developing and analyzing case studies on the incorporation of the approach in national research and extension systems. This effort should produce a synthesis of experience to date in this area.

Activities

On the matrix, the row headings indicate possible actions or activities that could/should be developed to improve the effectiveness of agricultural research and extension programs. Besides further work on traditional farming systems research, the range of possible activities include those designed to improve methodologies, deal with critical institutional issues and establish formal linkages to the agricultural policy-making process. Each topic is briefly discussed below.

Improvement of Farming Systems Methodologies.

1) Farmer Participation. While research and extension activities are carried out on farmers' fields, it often happens that the farmer himself is merely a bystander or laborer and is not effectively used in either the research design or research evaluation processes.
2) Crop-Livestock Interactions. Farming systems research had its origins mainly in cropping systems research, with little or no regard for the role or importance of livestock in farming systems.
3) Gender Issues. In many areas of the world, especially Africa but increasingly so in Asia and Latin America as well, women are playing an important role in farm production systems as both decision makers and providers of farm labor. Traditional research and extension systems often ignore this fact, with the result that the real users and potential evaluators of technology are misidentified.
4) Technology Transfer. Farming systems research is necessarily site-specific, but the resulting technologies developed may have wider application than is currently believed. There seems to be a need to identify new technologies as well as the conditions under which they are feasible/viable so that they may be made available to researchers and farmers in other parts of the country or in other countries.
5) Economic and Resource Sustainability. One area that does not always receive sufficient attention is the sustainability of new technologies, especially when they are designed for a specific set of circumstances that may be temporal in nature. This involves consideration of both the potential impact of the new technology on the natural resource base as well as the potential economic contribution toward maintenance of a viable family farming operation through adequate income levels at affordable input costs.

Institutional Issues.

1) Organization and Management. Farming systems research and extension is being implemented in several countries generally under a project that creates a special "farming systems unit" that is administratively and budgetarily separate from the rest of the host institution. As donor-funded projects terminate, or countries try to incorporate the approach into existing institutions without the benefit of a project, the question arises as to how to integrate, organize and manage critical functions.

2) Research-Extension Linkages. Questions continue regarding the dichotomy of research and extension and how these two can be successfully linked to form an effective technology generation and transfer system. Perhaps the farming systems approach, combining both research and extension at the field level, is the necessary integrator. The question still remains as to how to establish necessary linkages so that there is a more or less continuous backward and forward flow of information and technologies.

Policy Linkages: Farm-Based Policy Research. Agricultural policies, especially exchange rate and price policies, affect the private profitability of farm production and the attractiveness of new agricultural technology. New technologies are developed and/or introduced into specific policy environments that affect their adoption or rejection and the distribution of benefits between producers, consumers and others. Farming systems researchers have intimate knowledge of the systems they are working with that would be useful to policy analysts in order to help predict welfare and production effects of alternative policies. It would also be very useful for farming systems researchers to understand how policy impacts on the technologies they are developing.

PRIORITIES FOR FUTURE AID SUPPORT OF FARMING SYSTEMS

Should AID decide to continue its funding and fielding efforts to farming systems support worldwide, there is a need to establish priority work areas that are of greatest interest to AID and to identify mechanisms through which support can be channeled.

It is obvious that different groups with legitimate interests in farming systems work will have different sets of priorities for future activities. Such groups include, but are not limited to, USAID field missions, AID regional bureaus, U.S. universities and others who participated in the Support Entity Network, the international agricultural research centers, the national research and extension systems that have received assistance in establishing and operating farming systems projects and programs and other donors. Since budget limitations dictate that AID can neither support all activities nor place equal emphasis on those activities supported, it is necessary to make choices. The following is a suggested course of action for AID, based upon information provided by some of the interested groups, taking into account the limited resources available for farming-systems activities.

Mechanisms for Future Support

It seems clear that whether or not AID/S&T takes any action at this time regarding funding of farming systems activities, work in this area will continue for the foreseeable future. First, there are several projects with farming systems components currently underway or in the planning stages supported by AID as well as other donors. Second, as AID/S&T support for farming systems work is decreasing, support and activity by other organizations, such as the World Bank, IDRC, and the IARCS, is either stable or increasing. Within AID, the Africa Bureau continues to place priority on farming systems work as an integral part of its plan for agricultural research support. Third, the products of work during the previous five years, especially the training materials, are just emerging, providing the opportunity to further capitalize on previous investments.

At this point, there are three basic options that AID/S&T can consider with respect to future farming systems support.

Discontinue Support. An argument could be made that the farming systems approach has matured and developed a widely accepted set of concepts and operating procedures and is currently being supported by other donors, thus requiring no further support from S&T. However, the current consensus among practitioners as well as other donors is that there are a number of areas in which farming systems work needs improvement, as outlined in a previous section of this paper. Thus, given AIDs leadership role in promoting and supporting farming systems early on through bilateral projects, synthesis of experience and funding of the FSSP, it seems logical that at least a modest amount of support should continue to be provided.

Maintain Support at Previous Levels. Given the continuing importance of the farming systems approach as a strategy for development and transfer of agricultural technology to limited-resource farmers, it may be wise to fund a second phase of FSSP at a level and with a scope of work similar to the first phase. Questions arise regarding the nature of the design of the follow-on such as what activities are to be undertaken, the concentration of efforts in a region or regions and who should implement the project. Most important is the availability of resources to fund such an effort in an apparently ever-worsening budget situation. Given that available funds are already programmed, there would be a considerable lag period before a new project could get underway, perhaps as long-as three years.

Fold Farming Systems Into Other Projects. The basics of the farming systems approach are applicable to other subject areas as well as complementary to more general initiatives in agricultural technology generation and transfer. Thus, it may be possible to continue to support farming systems work under the "umbrella" of another effort. Two possibilities currently under consideration come to mind. First, Congress has mandated increased attention to the sustainability of current and future agricultural systems with regard to resource use and conservation, consistent with maintenance of acceptable family income levels. Conceivably, many elements of the farming systems approach could be used to concentrate on sustainability issues, especially with respect to the limited resource farmer client group.

Another possibility would be to specifically include farming systems in a new effort, the Agricultural Technology Initiative, now being designed (concept paper stage) for possible funding and implementation by S&T. The purpose of the initiative is to assist AID field missions and developing countries in the improvement of national systems for agricultural technology development, transfer and education. Work already done on farming systems would certainly make a significant contribution to the achievement of this objective, as well as provide continuity from previous efforts.

Establish a Farming Systems Secretariat. Given modest budgetary support ($100,000 to $300,000 per year), it would be possible to set up an independent secretariat to act as an information clearinghouse and promoter for future farming systems work. The secretariat would consist basically of a small professional and administrative staff consisting of a program leader, a data base management specialist, a grantsmanship advisor and a secretary. The activities of this core staff would be overseen by an advisory board consisting of highly-respected farming systems practitioners and donor representatives. The functions of the secretariat would be as follows:

- Act as a central clearinghouse for farming systems-related information.
- Establish a new Farming Systems Network consisting of all individuals and institutions interested in continuing farming systems development work worldwide. Membership in the network should be greatly expanded past the current FSSP Support Entity Network to include the IARCS, RARCS, NARS and others who have made significant contributions to the development of farming systems methodologies and are in a good position to collaborate on future efforts.
- Establish and maintain linkages with AID and other donors in order to assure continued financing for maintenance of the secretariat's core activities as well as support for specific initiatives.
- Help coordinate the supply of and demand for expertise in farming systems by:
  a. assisting Farming Systems Network members to encounter funding sources from among the interested donor community to support farming systems development and networking activities;
  b. maintaining a data base of individuals and institutions with proven farming systems expertise, especially in the areas of training and technical assistance; and
  c. stimulating the demand for farming systems expertise by promoting the basic ideas and concepts of farming systems development among the donor community and the potential adopters of farming systems methodologies.

In general, the secretariat is envisioned as a coordinating mechanism rather than an implementing mechanism as was the FSSP. It should as far as possible try to maintain an impartial and independent stance regarding implementation and funding, with all interested and capable parties receiving equal access to information and consideration for tasks that the secretariat may help generate.

Recommendations

The major ideas and concepts underpinning farming systems work continue to enjoy strong support and acceptance from the international donor community and the cadre of individual and institutional participants who have been involved in farming systems activities in recent years. Given AID's leading role in promoting and funding the approach, as well as the original ten-year scope of FSSP, S&T would be remiss if some level of support for the effort were not forthcoming. On the other hand, budget realities and a reduction in the lack of political support for a high level of activity in farming systems would tend to preclude a second phase of FSSP. Furthermore, given the level of activity in terms of bilateral technical assistance projects as well as strong interest of other donors, current levels of support to ongoing activities may be sufficient so as not to require another large project.

The farming systems approach should definitely be considered for incorporation as a component in new projects and programs that deal with agricultural technology and issues relating to limited-resource farmers.

Specifically, the approach should be part of an overall technology development and transfer strategy that looks at all parts of the research and development-extension-evaluation-adoption continuum. It offers a way of conceptualizing and developing the key institutional and informational linkages in the process that heretofore have not been present in traditional research-extension systems. Furthermore, the farming systems approach could contribute to the analysis and resolution of issues related to long-term sustainability of agricultural systems, given its client-oriented focus that provides knowledge regarding farm family needs and behavior.

It is far more important that the experiences and lessons learned from attempts at implementation of the farming systems approach be incorporated into the standard operating procedures of individuals and institutions involved in agricultural development than that the term "farming systems" survive. However, as stated previously, a number of activities need to be undertaken to fully realize the progress already achieved, as well as a number of areas that should be developed further to improve the efficiency and effectiveness of the technology development process. It is in the interest of AID/S&T to be involved and provide leadership in these areas. In order to ensure that this is accomplished, it is recommended that AID seriously consider funding a secretariat similar to that described above to act as a focal point for ongoing activities and networking related to farming systems.

Specifically, S&T would provide "seed" funding to enable the establishment of the secretariat, including rental of office space and equipment, employment of a small core staff, travel and other operating expenses for the first year. The suggested funding mechanism would be a grant. If AID resources are insufficient to fully fund this activity for a year, then AID should solicit collaboration from other donors such as the World Bank, the Ford Foundation, the Rockefeller Foundation and IDRC. In fact, even if funds are available, collaborative funding may be advisable in order to ensure broad interest and participation. The costs of starting up the secretariat could be reduced by placing it within another institution such as AID or the CGIAR Secretariat. In any case, care would have to be taken to ensure the operational independence of the secretariat so as to encourage broad participation from all of the major practitioners as well as donors.

One of the first tasks of the new secretariat would be to work to ensure its longer run survival by establishing self-financing mechanisms to be in place by the end of the first year. Such mechanisms could include:

- establishment of Network membership dues;
- solicitation of long-term pledges of funding from international donors and member institutions;
- establishment of a referral fee to be charged to Network member institutions that receive new business as a result of the secretariat's promotional efforts; and
- collection of proceeds from sales of subscriptions to network newsletters and other publications.

PRIORITIZATION OF FUTURE FARMING SYSTEMS ACTIVITIES

This section is based on the premise that AID will indeed continue support to farming systems work in some form. It presents a set of priority activities for consideration derived from the views and opinions expressed by various parties interested in strengthening and fostering the farming systems approach. Specific information is included in the appendices regarding the preferences expressed by the support entities of FSSP as well as a selection of AID field missions.

Conduct of an Impact Assessment

Although many projects and programs have been undertaken utilizing the farming systems approach, information regarding their impact on factors such as technology adoption, farm incomes and national research and extension system performance are scarce. A comprehensive examination of the successes and failures of several programs and projects should be undertaken in order to further clarify the expected benefits of the approach as well as to provide additional guidance as to where future work must be concentrated. Such a review should include AID projects, efforts supported by other donors and the activities of the IARCS.

Farming Systems Training

A great deal of the FSSP effort has gone into preparing training materials drawn from the collective experience of farming systems practitioners worldwide. There remains at the field level substantial interest in providing technical assistance in training and the capability to deliver that assistance has been developed through the FSSP Network and the IARCs. AID/S&T can further support training by facilitating publication and distribution of training materials and keeping field missions aware of where available technical expertise

may be found. Provisions need to be made to facilitate updating of materials as new lessons are learned and to incorporate new areas of knowledge as they are developed.

Institutionalization of the Farming Systems Approach in National Research and Extension Systems

Virtually all farming systems projects are linked with national research and extension systems in a variety of ways. Often they are attached as independent units with separate budgets because of the high recurrent costs associated with on-farm field work and the danger of diversion of funds toward other activities. As projects terminate, fanning systems units will have to find ways to compete for scarce resources with other parts of the system. Difficult choices will need to be made between employing larger numbers of people and maintaining a smaller force but with adequate tools to do the job at hand. As mentioned previously, ISNAR is currently taking a look at current experience with this issue. The results of that exercise should be carefully examined to determine what steps need to be taken in the future.

Transfer of Farming Systems Technology

In order to become more cost efficient, the technological recommendations stemming from site-specific farming systems work should be transferable to other areas with similar ecological and socioeconomic conditions. Technologies developed in one country may in fact be applicable in other countries and can be incorporated into the research-transfer continuum at a later stage of development. What seems to be lacking at this point is a mechanism to properly catalog new technologies, including providing complementary information regarding the conditions under which they are effective. AID should look into ways to catalog technologies so that they can be easily disseminated within countries, across borders and perhaps even across continents.

Linkages Between Farming Systems and Policy

In conducting farming systems research, researchers often obtain data and other types of farm-level information that are potentially valuable to agricultural policy analysts. In the same vein, farming systems researchers could benefit from a clearer understanding regarding how agricultural policies influence technology design and adoption. Very little has been published in this area. Efforts need to be made to determine what has been done and what can be learned from experience so far. From there, a conceptual framework could be developed to demonstrate how these linkages could best be accomplished and their potential relevance and contribution both to farming systems work and agricultural policy analysis and formulation.

Communication Among Practitioners

The functions previously performed by FSSP, collectively called networking, served to keep practitioners and other interested parties informed about developments in the field and provided an outlet for research results and other experiences. The mechanisms used were the newsletter, the annual symposium, technical publications called networking papers and "networkshops" that brought together practitioners in a region to discuss specific topics of mutual interest. These types of communication mechanisms are essential so that individual experiences can be shared and group resources can be mobilized to work on pressing problem areas and targets of opportunity. These sorts of activities are best funded by a central organization such as S&T, given the difficulties associated with joint funding of such activities.

LITERATURE CITED

1. Shaner, W. W., et al. 1981. Farming systems research and development: Guidelines for developing countries. Consortium for International Development, Westview Press.

ACTIONS TO IMPROVE EFFECTIVENESS OF AG RESEARCH AND EXTENSION SYSTEMS

	TRADITIONAL FS	IMPROVEMENT OF FS METHODS					INSTITUTIONAL ISSUES		POLICY LINKAGE
SEQUENCE OF STEPS FROM CONCEPTUALIZATION TO INSTITUTIONALIZATION	ON-FARM RESEARCH/ EXTENSION	FARMER PARTICIPATION IN RESEARCH	CROP-LIVESTOCK INTERACTIONS	GENDER ISSUES	TECHONOLOGY TRANSFER	ECONOMIC AND RESOURCE SUSTAINABILITY	ORGANIZATION & MANAGEMENT	RESEARCH-EXTENSION LINKAGES	FARM-BASED POLICY RESEARCH
PROBLEM IDENTIFICATION									
PROJECTS/PROGRAMS									
NETWORKING									
SYNTHESIS OF EXPERIENCE									
METHODOLOGY DEVELOPMENT									
TRAINING AND MAINTENANCE									
INSTITUTIONALIZATION									

Fig. 1. A framework for possible future activities to improve farming methodology.

APPENDIX A

POSSIBLE FUTURE DIRECTIONS OF FARMING SYSTEMS SUPPORT

This appendix contains information regarding farming systems activities that could be implemented in future efforts. As part of the concept paper preparation process, all AID missions were asked to provide information regarding whether or not they consider the topics important for their program, whether or not they would be willing to financially support efforts in each area and, finally, how they would rank each activity in order of importance. A sample answer form and tables summarizing mission response are included in this appendix.

Support of Ongoing Farming Systems Activities

This section presents some ideas regarding activities that are currently being undertaken by FSSP and others to promote the adoption of the farming systems approach in LDCS. All USAID field missions were queried as to the priorities they would place on each of the activities.

Training. Over the past few years, considerable progress has been made in operationalizing farming systems research and development in developing countries as well as in the United States. However, in many parts of the world, the process of learning and applying the farming systems approach is just beginning. In order to capitalize on the considerable investments already made in developing training materials and trainers, it may be appropriate to continue to provide both in-service and formal training.

- In-service training programs, in the form of short courses and workshops, could orient and assist local professionals involved in agricultural research and extension toward more effective involvement and service to farmers. Such courses would either introduce the basic concepts of farming systems or build upon the already-existing knowledge and experience base. Ideally, the training would occur periodically on a regular basis, with the content of the courses changing as local institutions evolve and become able to adopt new methods of technology development.
- Formal training could be targeted toward potential researchers and extensionists through local agricultural trade schools and universities. Rather than dealing directly with students, support in this area would concentrate on training faculty and staff as trainers so that, over time, most of the training functions would become self-sustaining with minimal outside support.

Networking/Newsletter. Farming systems research as a methodology of technological development is constantly evolving, encountering new constraints and finding ways to address them. It is important that farming systems practitioners worldwide build and maintain communications linkages so that joint learning can take place and people can be informed of new developments. Thus, support should be given for communication activities such as newsletters (regional, national and worldwide) and the support and improvement of existing networks of practitioners who share information and help advance the state of the art of the farming systems aspects of agricultural research.

Farming Systems Symposium. Since 1981, the annual Farming Systems Symposium has brought together farming systems professionals from all over the world to share experiences, report on new developments and renew and maintain personal and professional contacts. A new project could also support the organization of regional symposia in order to promote better communications among farming systems professionals working under similar environmental and cultural conditions.

New Directions in Farming Systems

Experience in undertaking farming systems projects has revealed areas of weakness in the farming systems approach as currently envisioned in being able to reach the goals of increased food availability and rural incomes. This set of topics deals with new directions in which farming systems work could be examined and addressed to improve the effectiveness of the farming systems approach as a development methodology.

Periodic Rapid Reappraisal. One of the drawbacks of the project approach to development is that once the project is designed and technical, assistance is fielded, it is difficult to add activities to address unanticipated constraints that may arise preventing attainment of project goals. In order to address this problem, the new project could promote a periodic rapid appraisal approach to examine, besides farm-level technical and socioeconomic constraints, conditions with respect to access and efficiency of agricultural markets, access and cost of credit and the general price policy environment. This would be undertaken in specific regions of interest to AID

Missions to determine whether there is scope for significant technological and productivity improvements and to assess whether or not changes in productivity would likely result in increased household incomes, enhanced availability of food and better management of the existing natural resources base. Service in this regard would be provided to missions in the form of multidisciplinary teams to perform the rapid appraisal and offer guidance as to which factors are most limiting and should be treated by establishing linkages among existing projects and activities (e.g., between a farming systems research project and an agricultural policy analysis project).

Linkages Between Farming Systems and Policy. One of the criticisms that has been leveled at farming systems approaches is that they tend to take restrictive economic conditions (such as difficult access to credit and markets, low product prices, high input prices) as given and static. One of the possible roads to improved productivity is to relax economic constraints so that existing technologies can be adopted or more productive technologies can be developed for a less restrictive environment. This points out the need for improved communication between farming systems researchers and planners/policy makers. In the process of farming systems research, information about farms and farm households is generated that could help policy makers understand the income and output effects of current policies as well as help predict response to policy changes. Efforts could be undertaken to help establish and maintain communication linkages so that farm- and village-level information be available in a usable form, enabling decision makers to make better policy decisions. Such an effort built upon the recently developed Policy Analysis Matrix methodology explicitly uses the micro-level cost and returns information commonly gathered by farming systems researchers as an aid in developing policy reform recommendations.

Technology Transfer. Though the farming systems approach incorporates concepts and methodologies relating to both agricultural research and extension, there is a continuing concern regarding the means for passing new technologies from the research community to the ultimate users, the farmers. INTERPAKS, a centrally-funded project looking at agricultural knowledge transfer systems, is exploring ways to make existing extension systems more effective in bringing about positive technological change. Through its emphasis on field work, a new project may be able to test and help develop new means and methods of effective technology transfer.

Evaluation of the Effectiveness of Farming Systems Work

This section presents two topics of interest in determining how effective farming systems work has been in the past, with a view to ratifying its strategy or suggesting modifications that may bring about better results.

Cost/Benefit Analysis. It is believed by many researchers that the recurrent costs of farming systems research and extension are generally higher than those for on-station research. To test this assertion, a possible new initiative could be undertaken to examine whether the added benefits of a farming systems approach, in which the clients are heavily involved in the technology development process, compensate for the added institutional and financial costs. This issue could be explored using a case study approach to document costs and benefits, not only in financial term but also in terms of the equity with which technological change benefits farmers as well as the effects of technology on the natural and cultural environments.

Integration of the Farming Systems Approach into Local Institutions. Farming systems efforts have been ongoing at various levels of intensity for several years. Has the farming systems approach been integrated into the standard operating procedures of local institutions, or is it a breed apart dependent on outside funding for its existence? How can the farming systems approach be integrated into national agricultural research and extension systems in order to improve the performance and responsiveness of the overall system? How has the responsiveness of the national agricultural research institutions toward small farmers changed? How are the multi-disciplinary issues being handled in the various countries, given the trained manpower shortages? These questions could be explored using a case study approach.

SAMPLE OF QUESTIONNAIRE SENT TO MISSIONS

1. How do you view the importance and relevance to your mission of each of the above types of proposed services and research issues? Would the mission be willing and able to share costs?

HIGH PRIORITY	A1	A2	A3	B1	B2	B3	C1	C2
MEDIUM PRIORITY	A1	A2	A3	B1	B2	B3	C1	C2
LOW PRIORITY	A1	A2	A3	B1	B2	B3	C1	C2
WILLING TO COST SHARE	A1	A2	A3	B1	B2	B3	C1	C2
UNWILLING TO COST SHARE	A1	A2	A3	B1	B2	B3	C1	C2

2. Please rank order functions according to their importance to your mission.

_____ Training
_____ Networking/Newsletter
_____ Symposium
_____ Periodic appraisals
_____ Policy linkages
_____ Cost/Benefit Analysis
_____ Integration into local institutions
_____ Technology Transfer Emphasis

INDICATIONS OF SUPPORT OF USAID MISSIONS OF CURRENT AND FUTURE FARMING SYSTEMS SUPPORT ACTIVITIES

RANKINGS	TRAINING	NETWORK/ NEWSLTR	SYM- POSIUM	PERIODIC APPRAISAL	POLICY LINKAGES	COST- BENEFIT	INSTITU- TIONALIZE	TECHNOLGY TRANSFER
BOTSWANA	H/N	H/Y	H/Y	M/N	H/N	?/N	H/N	M/N
THE GAMBIA	M/Y	M/Y	M/Y	L/Y	H/Y	H/Y	H/Y	H/Y
KENYA	H/Y	M/Y	M/Y	M/N	L/N	L/N	H/Y	H/Y
LESOTHO	H/N	M/N	L/N	L/N	M/N	M/N	H/N	H/N
MALI	H/?	H/?	H/?	H/?	?/?	H/?	M/?	H/?
SOMALIA	H/N	?/N	?/N	?/N	M/N	L/N	L/N	M/N
ZAMBIA	M/N	M/N	H/N	M/N	H/N	L/N	M/N	M/N
TOTALS AFR MISSIONS								
HIGH PRIORITY (H)	5	2	3	1	3	2	4	4
MEDIUM PRIORITY (M)	2	4	2	3	2	1	2	3
LOW PRIORITY (L)	0	0	1	2	1	3	1	0
COST SHARE? (Y)	2	3	3	1	1	1	2	2
COST SHARE? (N)	4	3	3	5	5	5	4	4
BURMA	H/N	L/N	L/N	L/N	L/N	L/N	M/N	L/N
EGYPT	H/Y	L/Y	L/Y	L/Y	M/Y	H/Y	H/Y	H/Y
FIJI	M/Y	M/N	L/Y	L/N	L/N	L/N	L/N	L/N
PAKISTAN	H/Y	M/Y	H/Y	?/?	L/?	L/?	M/Y	M/?
PHILIPPINES	H/Y	L/N	M/Y	M/Y	H/Y	H/Y	H/Y	M/Y
SRI LANKA	H/?	M/N						H/N
THAILAND	L/N	M/N	H/Y		L/N	L/N	L/N	M/N
TOTALS ANE MISSIONS								
HIGH PRIORITY (H)	5	0	2	0	1	2	2	2
MEDIUM PRIORITY (M)	1	4	1	1	1	0	2	3
LOW PRIORITY (L)	1	3	3	3	4	4	2	2
COST SHARE? (Y)	4	2	5	2	2	2	3	2
COST SHARE? (N)	2	5	1	2	3	3	3	4
BELIZE	H/Y	M/N	L/N	H/Y	H/Y	M/Y	H/Y	M/Y
BOLIVIA	H/Y	M/N	L/N		M/N	M/Y	H/Y	H/Y
DOMINICAN REPUBLIC	L/N	L/N	L/N	L/N	L/N	L/N	L/N	L/N
ECUADOR	H/Y	M/N	L/N	M/Y	M/Y	L/N	M/N	M/Y
EL SALVADOR			?/Y	H/?			M/N	
HAITI	H/?	L/?	M/?	L/?	H/Y	M/?	H/Y	M/?
HONDURAS	H/Y	L/?	M/?	H/Y	M/?	H/Y	M/?	M/?
JAMAICA	M/Y	L/N	L/N	M/N	M/N	M/N	H/N	H/Y
TOTALS LAC MISSIONS								
HIGH PRIORITY (H)	5	0	0	3	2	1	4	2
MEDIUM PRIORITY (M)	1	3	2	2	4	4	3	4
LOW PRIORITY (L)	1	4	5	2	1	2	1	1
COST SHARE? (Y)	5	0	1	3	3	3	3	4
COST SHARE? (N)	1	5	5	2	3	3	4	1
TOTALS ALL MISSIONS								
HIGH PRIORITY (H)	15	2	5	4	6	5	10	8
MEDIUM PRIORITY (M)	4	11	5	6	7	5	7	10
LOW PRIORITY (L)	2	7	9	7	6	9	4	3
COST SHARE? (Y)	13	5	9	10	10	10	10	10
COST SHARE? (N)	7	13	9	9	11	11	11	9

RANK ORDER OF PRIORITY INTERESTS OF USAID MISSIONS IN FARMING SYSTEMS ACTIVITIES

RANKINGS	ACTIVITY							
	TRAINING	NETWORK/ NEWSLTR	SYM- POSIUM	PERIODIC APPRAISAL	POLICY LINKAGES	COST- BENEFIT	INSTITU- TIONALIZE	TECHNOLGY TRANSFER
BOTSWANA								
THE GAMBIA	4	6	7	8	1	5	3	2
KENYA	2	3	4	7	6	8	5	1
LESOTHO								
MALI								
RWANDA								
SOMALIA	1	2	5		4			3
ZAMBIA	4	7	6	5	1	8	3	2
REDSO/ESA	1	4	8	6	5	7	3	2
AFR MISSIONS AVERAGE								
RANK	2	5	6	7	3	8	4	1
SCORE	2.40	4.40	6.00	6.50	3.40	7.00	3.50	2.00
BURMA	1	5	4	2	3	8	7	6
EGYPT	2	8	5	4	3	7	6	1
FIJI		1					3	2
PAKISTAN	2	3	1			5	4	
PHILIPPINES	5	8	5	5	1	1	1	1
SRI LANKA	2	3						
THAILAND	8	2	1	5	4	6	3	7
ANE MISSIONS								
RANK	3	7	2	5(TIE)	1	8	5(TIE)	4
SCORE	3.33	4.29	3.20	4.00	2.75	5.40	4.00	3.40
BELIZE	1	7	8	2	3	6	4	5
BOLIVIA	3	7	8	6	2	1	4	5
DOMINICAN REPUBLIC								1
ECUADOR	1	2	8	3	4	7	6	5
EL SALVADOR	1	7	5	8	4	6	2	3
HAITI	2		4		3		1	
HONDURAS	1	8	7	2	5	6	3	4
JAMAICA	4	7	6	8	5	3	2	1
LAC MISSIONS								
RANK	1	7	8	5(TIE)	4	5(TIE)	2	3
SCORE	1.86	6.33	6.57	4.83	3.71	4.83	3.14	3.43
ALL MISSIONS								
OVERALL RANK	1	5	7	6	3	8	4	2
OVERALL SCORE	2.50	5.00	5.41	5.07	3.38	5.60	3.53	3.00

APPENDIX B

RESPONSES TO QUESTIONNAIRE

Several members (20) of the FSSP Support Entity Network were asked to respond to a questionnaire that contained open-ended questions about their perceptions regarding FSSP performance and their views as to what activities should be included in a possible FSSP follow-on project. The question asked in this regard is as follows:

> Do you think there should be a follow-on to FSSP? If not, why not? If so, what would some of the areas/activities that should be incorporated or focused on?

Twelve responses to the questionnaire were received. The following is a listing of the responses, with the numbers in parentheses indicating the frequencies of each response. As is clear, the majority of responses indicated strong preference for maintenance of activities associated with communications and networking, especially the newsletter, domestic networks and the symposium. The major substantive area frequently mentioned was the continuation of training in farming systems methodology.

- Newsletter (10)
- Networks (10)
  Domestic (8)
  Regional (2)
- Training (7)
- Symposium (5)
- Library (1)
- Institutionalization (1)
- Regional Networks (2)
- Policy Linkages (1)
- Livestock (1)
- Perrenials (1)
- Evaluation of FSR/E(1)
- Farmer participation (2)
- Technology Information Bank (1)
- Roster of FSR Experts (1)

RESPONSE TO "POSSIBLE FUTURE DIRECTIONS FOR AID ACTIVITY IN FARMING SYSTEMS RESEARCH: A CONCEPT PAPER"

Rosalie Huisinga Norem[1]

INTRODUCTION

On November 9-10, 1987, the Farming Systems Network Steering Committee met in Washington, D.C. The committee worked on identifying key points that needed to be addressed in considering the future of farming systems as an approach to agricultural development. This was in keeping with the charge to the committee of developing such a concept paper. USAID/S&T/AGR had also contracted with Chemonics Internation Consulting Division to prepare a concept paper on the "Possible Future Directions of Farming Systems Research and Extension." The Steering Committee received copies of the Chemonics paper in the Spring of 1988 (Chapman and Brown, 1989) and modified its plans for a concept paper to prepare a response to the Chemonics paper.

The concept paper prepared by Chapman and Brown provides the basis for consideration of what comes next in the development of the farming systems approach. The Steering Committee views the paper as a positive look forward, with constructive suggestions for the "how to" of moving ahead. This paper builds on the Chapman and Brown paper with discussion of several of their major points, and some additional questions and suggestions.

CONSISTENCIES BETWEEN THE CONCEPT PAPER AND STEERING COMMITTEE IDEAS

In order to assess the Chapman and Brown paper in context of the Steering Committee's Plans for a concept paper, the points identified by the committee in the November 1987 meeting were used as a guide, and those points were "crosswalked" with the Brown and Chapman paper to make sure all issues were covered. Although the organization of major points is different in the two outlines, the content areas are strikingly similar. This similarity, of course, is one of the reasons the Steering committee took the approach of strong support of the basic premises of the concept paper. The points identified by the Steering Committee in its initial deliberations about a concept paper are as presented below, with a short summary of how the concept paper dealt with each point.

- Micro-macro policy. It is important to recognize policy and linkage issues in the institutionalization of farming systems. This is a factor for research, extension and broader agricultural policy. Policy issues have not received extensive attention in farming systems work, but this is an area where more work should be done. The specific suggestions about "farm-based policy research" (p. 375, this volume) are an example. Policy linkage is identified as an action-needed to improve agricultural research and extension systems.
- Strengthening FSRE linkages to Commodity Research. Farming systems should be viewed as one alternative tool within the repertoire of development approaches. Its methods can make an important contribution to more effectively targeted commodity research. This involves working with IARCS, RARCS and other commodity research groups.
- Participation of farmer and farmer organizations in FSRE. Chapman and Brown (p. 371) discuss the basic client orientation of farming systems as part of the "essence of farming systems." This is a contribution the approach makes to agricultural development overall and the methods developed in farming systems work for facilitating this farmer involvement have much to contribute to other development efforts.
- Advances in methodology for design and analysis of on-farm trials. Farming systems has made important
  contributions to this methodology, with the collaboration of several groups.
- Advances in evaluation methodology/continuation of assessment of farming systems impact. The concept paper recommends a "comprehensive evaluation" to assess benefits of FSR/E as well as to guide future

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work. One such assessment of the impact of farming systems was completed by the Farming System Network Steering Committee and is reported elsewhere.

- Refinement of rapid rural appraisal techniques. Farming systems has contributed significantly to these techniques because of its orientation on the process of working with farmers and because of its client-based focus.
- Definition of diffusion domains. This concept was not discussed specifically in the concept paper, but the importance of research-extension linkages was stressed. Farming systems, as an approach, holds promise for facilitating this integration. The development of the idea of diffusion domains is one example of how this integration might be implemented.
- Integration of intrahousehold components into diagnosis, design, implementation and policy. Gender and household issues are among the categories identified as needing action to improve farming systems methods (p. 374). The client orientation and process emphases of farming systems provide methods for facilitating this improvement.
- Role of U.S. Research and Extension Institutions in farming systems projects and project support efforts. This is dealt with primarily under discussion of networking and linkages. The need for trained farming systems professionals is also emphasized at several points. U.S. institutions are part of the existing network and have an important contribution to make to future training and education, both of farming systems professionals and in the integration of the contributions of farming systems methods into development training programs in a general sense.
- Relationships of farming systems to CRSPs and IARCS. The importance of linkages is discussed repeatedly, and institutional issues are among those identified as areas needing action to improve effectiveness. The contributions made by collaborative efforts with IARCs and other groups are used as examples of past and ongoing actions.
- Technology implementation. The existing and potential relationship between farming systems and the overall development, implementation, and transfer-of technology is highlighted at several points. Technology transfer is among the "action-needed" components of the framework for possible future activities (p. 374).
- Natural resources. There is a focus on the need for actions to improve assessment of "the potential impact of the new technology on the natural resource base," and this is included in among the actions needed (p. 374).
- Regional coordination. Several examples of regional network activities are listed (P. 374). These include the Asian Cropping Systems Network, the West African Farming Systems Research Network (WAFSRN) and the Integrated Livestock Farming Systems Network. Continued development of such regional efforts can add significantly to overall linkage opportunities and potential methodological advances.
- Mechanisms for mobilization of human resources in farming systems research and extension. The issues focusing on this point include networking activities, training and education and continued development of research and extension efforts. The need for efforts in this area is highlighted by discussion of concerns about the availability of qualified farming systems professionals.

One additional point was identified by the Steering Committee that does not specifically appear in the Chapman and Brown paper but relates to issues of training, institutionalization and directions for future support. This is the orientation for USAID personnel and systematic debriefing of project personnel to facilitate information transfer and institutional memory.

MAJOR CONTRIBUTIONS OF THE FARMING SYSTEMS APPROACH

Four attributes of the farming systems approach that are important contributions to agricultural development are discussed in the concept paper.

1. Farming systems takes a basic client orientation. This orientation can facilitate the identification of problem priorities, design of projects and programs and the design and evaluation of technology and policy. Methods such as rapid rural appraisal techniques and gender and household analysis hold promise for a variety of development efforts, both in agriculture and other sectors.
2. Farming systems is a holistic, systems approach. There is the recognition that problems arise and must be solved in a context of the total household and production system.

3. Farming systems is an approach that functions as a process. The methods and techniques provide a basis for understanding how, when, where and why activities occur and decisions are made in the production process.
4. The farming systems approach has facilitated the growth of an interdisciplinary network of professionals interested in helping address development problems.

Each of these contributions of the farming systems approach to agricultural development substantiates the basic recommendation in the concept paper that some support be continued for farming systems. The Steering Committee also recommends that support be continued for farming systems. The following section of this response to the concept paper discusses the alternatives for support presented in that paper.

ALTERNATIVES FOR FUTURE SUPPORT OF FARMING SYSTEMS

1. Maintain support at previous levels. The committee agrees that to tie support to a follow-up project to FSSP with problems of lag time and limited funding, may not be the most functional alternative at this time. It is important that ongoing work continue and that funding be considered in a flexible manner. Perhaps this means a combination of approaches to funding farming systems.
2. Fold farming systems into other projects. The concept paper makes a good case for integration of farming systems methods and techniques into the overall development process, taking advantage of the contributions farming systems can make to agricultural development. This will be a "folding in" to some extent. As pointed out in the concept paper, farming systems has strengths that can be of value to efforts focused on sustainability of agricultural systems. If farming systems is successful, there will and should be some "folding in. " This does not preclude the need for other funding that provides for continued development of the more unique elements of farming systems.
3. Establish a farming systems secretariat. This is a creative idea for continued support to farming systems. The Steering Committee does, however, question whether the level of funding and the time line for initial funding are adequate for such a secretariat to perform the functions outlined in the concept paper. We suggest a funding level within a range from $300,000 to $500,000 a year, with initial seed funding established for a three-year period. It is questionable whether a secretariat could realistically expect to generate funds for support by the end of the first year. Perhaps there could be a phasing out of seed funding starting the second year. This needs to be examined very carefully so that a secretariat is not set up in such a way that it cannot succeed.

The functions being suggested for a secretariat provide a good starting place for defining objectives. The committee supports this alternative for future funding.

FUTURE FARMING SYSTEMS ACTIVITIES

The Chapman and Brown paper provides an important direction for farming systems by their prioritization of future activities. There is a need for additional impact assessment if future efforts are to build effectively on what has been done in the past.

The Steering Committee also concurs that farming systems training is of critical importance. In initial discussion about topics for a concept paper, the committee supported the need for integrating training and development of training into all of the other key elements presented in an earlier section of this response. Training is not only important as one of the steps in the sequence from problem identification To institutionalization (see the "Framework for Possible Future Activities to Improve Farming Systems," page 379) but may be an important component of each of the other steps in that sequence. Training in methods of problem identification, for example, may provide additional skills for identifying a problem from the client's perspective. Training in using a process approach and gender and household analysis may facilitate the design of projects and programs. Similar examples could be given for other steps in the sequence.

The importance of training is also demonstrated by the results of a survey of AID missions, as appended to the concept paper. Training was ranked as the highest priority by more missions than any other activity. The fact that missions also indicated training was an activity they were most likely to cost share provided further support. As future funding alternatives are considered, training needs should also be considered. If a secretariat is funded with the responsibility for facilitating training, the budget needs to have a realistic apportionment for this purpose.

SUMMARY

The Steering Committee of the Farming Systems Network supports the ideas presented in the concept paper prepared by Chapman and Brown of Chemonics, Inc. We urge careful consideration of the ideas presented in the paper by the Farming Systems Network and the fundors. There are several other sources of recommendations that should be considered as well. Those sources are listed in the references at the end of this paper and are identified here to identify (1) those aspects of the farming systems approach that are important for agricultural development work and (2) to review recommendations that have been a part of several documents, prepared by several different groups.

Farming systems has evolved methods that have the following strengths. Farming systems is

1. farmer-oriented
2. interdisciplinary in problem identification and problem solving
3. oriented toward location-specific interventions
4. sensitive to the total system involved in small-scale production, including household and gender issues.

These aspects of farming systems have been integrated in to agriculture development programs in Africa, Asia, and Latin America. The concept and methodology were extended to these regions, and they now have strong farming systems teams with a particular client group. Farming systems was relevant to their client group, and they believe in it. The question is not whether farming systems as a label will continue to be a funding priority, but whether the principles of farming systems will continue to be supported as an important component of development efforts.

There have been many criticisms of the ambiguities in the definitions of farming systems. But, as pointed out by several sources (Brown and Chapman, 1989; Byrnes, 1988) perhaps the time frame in which evaluations have been made is inappropriate for adequate assessment of the progress of farming systems. Because farming systems is a process, it is difficult, and perhaps unrealistic, to quantify yield increases or other common production indicators and use them as evaluation criteria for one part of the process.

The question of responsibility to provide backstopping through training, continued refinement of methodology, and network linkages must be faced in the context of past activities in development research.

Continued refinement of methodologies, training materials and workshops, university programs in farming systems, and continued linkage activities such as regional and international newsletters and symposia are among the needs identified in most evaluations and reviews of farming systems.

If AID funding is critical for continued development in the above areas, then perhaps a change in terminology should be considered. Farming systems is a long-term approach, at the slowest end of agricultural development, which is overall a long-term effort. It does not lend itself easily to the typical 5-year funding cycle common in development funding.

The Farming Systems Steering Committee suggests that all development projects can gain from incorporating some of the strengths of farming systems as an approach. The interest and concern evidenced by the formation of the Farming Systems Network demonstrates the commitment of many development experts to maintaining the strengths of farming systems. We urge continued efforts to fund, through a variety of sources, those critical elements of farming systems that have evolved through the work of researchers and practitioners around the world.

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Commissioned Paper
In Preparation for
1989 FSR/E Symposium

FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E) IN SUPPORT OF SUSTAINABLE AGRICULTURE

Charles A. Francis and Peter E. Hildebrand[1]

This paper defines a close and complementary relationship between Farming Systems Research and Extension (FSR/E) and sustainable agriculture. Sustainable agriculture is a set of goals or objectives for agricultural systems. FSR/E is a methodology that incorporates a systems, or holistic, perspective. When the time dimension is incorporated in the systems perspective, sustainability necessarily becomes a concern in FSR/E.

Concern about the sustainability of agricultural production has been expressed in books throughout most of this century: *Farmers of Forty Centuries* (King, 1911); *An Agricultural Testament* (Howard, 1943); and *Feeding a Billion* (Wittwer et al., 1987). Growing interest in this concept has developed over the past several years. The National Research Council of the National Academy of Sciences of the United States is, at this writing, completing a major study on "alternative" agriculture (National Research Council, 1989). Recent USAID and World Bank projects, among others, must demonstrate concern with "sustainability." Yet the growing dialogue has not contributed to a single definition of the term "sustainable."

A mechanistic definition is used by the Cooperative Extension System in Nebraska (Univ. Nebraska, 1987):

> A sustainable agricultural system is the result of a management strategy which helps the producer to choose hybrids and varieties, soil fertility packages including rotations, pest management approach, tillage methods and crop sequence to reduce costs of purchased inputs, minimize the impact of the system on the immediate and the off-farm environment, and provide a sustained level of production and profit from farming.

More recently, Harwood (1988) defined sustainable agriculture as:

> … an agriculture that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment that is favorable both to humans and to most other species.

The Committee on Agricultural Sustainability for Developing Countries (1988), "a coalition of organizations concerned about agricultural development" in a concept paper defines sustainability in agriculture as:

> ... the ability of an agricultural system to meet evolving human needs without destroying and, if possible, improving the natural resource base on which it depends.

The *Agronomy News*, in January 1989, reported a consensus achieved by 350 members of the ASA, CSSA and SSSA following a "free wheeling two-hour discussion" (ASA/CSSA/SSSA, 1989):

> A sustainable agriculture is one that, over the long term, enhances environmental quality and the resource base on which agriculture depends; provides for basic human food and fiber needs, is economically viable, and enhances the quality of life for farmers and society as a whole.

This group, as have others, agreed that the concept of "low-inputs" is not essential to sustainable agriculture but under some circumstances may be an appropriate approach to meeting the four criteria listed in the definition.

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As reported by E.T. York in a recent issue of *Environment* (York, 1988) the Technical Advisory Committee of the CGIAR considers that

> The goal of sustainable agriculture should be to maintain agricultural production at levels necessary to meet the increasing needs and aspirations of an expanding world population without degrading the environment.

Some of the above statements convey the concept of sustainable agriculture as a philosophy. The TAC statement expresses sustainable agriculture as a goal to be achieved. It is in this latter context that the relationship between sustainable agriculture (an end) and farming systems as a clearly defined methodology (a means to an end) can be seen.

The current polemic on sustainable agriculture obviously manifests a concern with the thought that modern agriculture, as practiced in much of the world today, is non-sustainable. Conventional technologies and strategies have led to an agriculture that uses non-renewable resources at rates that cannot be sustained and/or that creates a gradual contamination of the environment. Through the use of petroleum-based products for mechanization and chemically enhanced production practices, non-sustainable agriculture as we know it today is in part the result of standardized practices over large geographic areas.

The opposite extreme, a perfectly sustainable agriculture (one that could go on forever), no longer dominates. It is found only in a few cases and as isolated habitation in the world's largest humid tropical forests where the population density is so low that the environment can recuperate from the occasional slash and burn scars created in the process of sustaining human life.

A practical working definition of "sustainable" must lie between these two extremes. In this context, it would probably be useful to speak of "a more sustainable agriculture" rather than the absolute term "sustainable." A more sustainable agriculture- than that being practiced in what we might call "modern agriculture" today-would rely less on standardized, often chemically-enhanced production practices and instead depend on renewable resources and use practices more in tune with local conditions. This implies more diversity in crops produced, changes in rotation practices, the development (or redevelopment) of germplasm well adapted to local environmental niches (as opposed to germplasm with "broad adaptability") and the necessary accompanying changes in infrastructure. A more sustainable agriculture would be more in tune with the local resource base, make maximum use of internal production inputs and have potential for sustained production and profits farther into the future.

Farming Systems Research and Extension methodology is well adapted to help create the type of technology envisioned in a more sustainable agriculture. FSR/E methodology

1) was developed to help generate technology that fits the particular types of farming systems in a specific location;
2) has been especially successful in areas where conditions often change rapidly from one zone or ethnic group to another;
3) is an approach that acknowledges diversity as implied in the concept of "Recommendation Domains" (Harrington and Tripp, 1984).

Diversity, in turn, implies the need for problem solving from many perspectives. FSR/E procedures

4) have come to grips with the challenges of combining disciplines to help solve problems whose solutions often lie outside the mandates of single departments or commodity programs, or even outside the traditional agricultural university or research institute;
5) feature partnership with farming families who help in its planning and implementation.

The current rate of degradation of the environment demands urgency in achieving more sustainable agricultural practices. In practice, FSR/E

6) reduces the time from conceptualization to adoption by incorporating the knowledge base of farmers into the process of technology generation;
7) stimulates the acquisition and use of new technological information by farmers by helping them learn about it first hand. This is critical because sustainable agriculture requires more management time, substituting information for external inputs.

By its very nature, then, FSR/E methodology is distinctly appropriate for helping develop the kind of agricultural practices that are more in tune with local resources, that will help to enhance the environment and, ultimately, help create a more sustainable agriculture.

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