"IMPACTS OF FARMING SYSTEMS RESEARCH/ EXTENSION ON SUSTAINABLE AGRICULTURE"

1989 Farming Systems Research/Extension Symposium
October 8-11

Conference Themes:

- *FSR/E and the Concepts of Sustainability*
- *The Role of Farming Systems in Sustaining:*
  - *Productivity and Profitability*
  - *Farmer Participation in Agricultural Development*
  - *Institutional Development*
  - *Environmental Quality*
- *Special Topics*

To address the special regional concerns of developing countries, and provide a forum for the growing interest in Farming Systems in the United States, the first full day of the Symposium, October 9, will be organized around concurrent sessions with a regional focus on:

Africa
Asia/Near East
Latin America
United States

1989 FARMING SYSTEMS RESEARCH/ EXTENSION SYMPOSIUM

Program and Abstracts

ARKANSAS/OKLAHOMA LISA NETWORK CONFERENCE

Sunday, October 8

"FARMER PARTICIPATION IN RESEARCH FOR SUSTAINABLE AGRICULTURE"

Time	Room	
7:30am-9:00am	4th Floor Lobby	Registration
8:00am-9:00am	CCE 405	Continental Breakfast
9:00am-9:15am	CCE 402	Introductions
9:15am-10:00am	CCE 402	Keynote Address: Dr. Charles Francis University of Nebraska "Farmer Participation in Research for Sustainable Agriculture"
10:00am-11:00am	CCE 402	Panel: "Case Studies of On-Farm Research"
11:00am-11:30am	CCE 405	Break
11:30am-12:00pm	CCE 402 CCE 407 CCE 409	Simultaneous Workshop Sessions: Planning an On-Farm Research Project
12:30pm	4th Floor	Lunch
1:00pm-1:45pm	CCE 402	Luncheon Speaker: Dr. William Lockeretz Tufts University "On-Farm Research, Potentials and Limitations"
1:45pm-2:45pm	CCE 402	Panel: "Farmer Participation in Determining the Land-Grant University Research Agenda"
2:45pm-3:00pm	CCE 405	Break
3:00pm-4:10pm	CCE 402 CCE 407 CCE 409	Simultaneous Workshop Sessions: "Appropriate Topics and Methodologies for On-Farm Research" "Finding Funding for On-Farm Research" "How to Find a Research Cooperator"
4:10pm-4:30pm	CCE 402	USDA LISA Update: Dr. Neill Schaller National Project Leader Low-Input Sustainable Agriculture Research and Education Program CRS, USDA, Washington, D.C.
4:30pm-5:00pm	CCE 402	Program Wrap-up Adjourn

1989 FARMING SYSTEMS RESEARCH/EXTENSION SYMPOSIUM

Sunday, October 8

"IMPACTS OF FARMING SYSTEMS RESEARCH/EXTENSION ON SUSTAINABLE AGRICULTURE"

Time	Room	
1:00pm-5:00pm	CCE 2nd Floor Lobby	FSR/E Symposium Registration
6:00pm-6:45pm	CCE 204	Opening Remarks and Welcome to the 1989 Farming Systems Research /Extension Symposium
6:45pm-9:00pm	Hilton/ Sequoyah Ballroom	Symposium Opening Reception

Monday, October 9

Time	Room	Session Number	
7:00am-8:00am	Hilton Atrium		Continental Breakfast
8:00am-8:45am	CCE 204	1	**Keynote Address:** Dr. Mohan Man Sainju The Royal Kingdom of Nepal Ambassador to the U.S.
8:45am-9:30am	CCE 204	2	**Meeting:** Association for Sustainable Farming Systems Research/Extension
9:30am-10:00am	Hilton Atrium		Break

Concurrent Regional Sessions

Concurrent sessions focused on four major regions of the world.

AFRICA

10:00am-10:50am	CCE 402	3	African Experience Increasing Farmer Participation in Agricultural Development
10:50am-11:30am	CCE 402	4	Impacts of FSR/E on Sustained Food Production in Africa
11:30pm-1:00pm	Open		Lunch
1:00pm-1:40pm	CCE 402	5	Environmental Sustainability in African Farming Systems
1:40pm-2:30pm	CCE 402	6	Contributions to the Concepts of Sustainability in African Farming Systems
2:30pm-3:00pm	CCE 2nd & 4th Floor Lobbies		Break
3:00pm-4:00pm	CCE 402	7	Sustainable Strategies for Increasing Food Production in Africa
4:00pm-4:30pm	CCE 402	8	Institutional Sustainability of FSR/E Within the African Context

ASIA/NEAR EAST

10:00am-11:30am	CCE 405	9	Farmer Participation
10:00am-11:30pm	CCE 405	10	Productivity and Profitability
11:30am-1:00pm	Open		Lunch
1:00pm-2:30pm	CCE 405	11	Institutional Development
1:00pm-2:30pm	CCE 405	12	Special Topics: Indigenous Knowledge Systems; FSR Impact Assessment
2:30pm-3:00pm	CCE 2nd & 4th Floor Lobbies		Break
3:00pm-4:30pm	CCE 405	13	Concepts of Sustainability

LATIN AMERICA

10:00am-11:30am	CCE 409	14	Systems Description/Diagnosis, Traditional Technology
11:30am-1:00pm	Open		Lunch
1:00pm-2:30pm	CCE 409	15	Monitoring and Technology Adoption
2:30pm-3:00pm	CCE 2nd & 4th Floor Lobbies		Break
3:00pm-4:30pm	CCE 409	16	Institutionalization of the Farming Systems Approach

UNITED STATES

10:00am-10:48am	CCE 105	17	Institutional Development
10:48am-11:30am	CCE 105	18	Farmer Participation
11:30am-1:00pm	Open		Lunch
1:00pm-1:18pm	CCE 105	19	Environmental Quality
1:18pm-2:30pm	CCE 105	20	Productivity and Profitability
2:30pm-3:00pm	CCE 2nd & 4th Floor Lobbies		Break
3:00pm-4:30pm	CCE 105	21	Special Session: Computer-Based Decision Aids for Farming Systems

SPECIAL SESSION: PANEL PRESENTATION

4:30pm-5:30pm	CCE 204	22	Making Sustainable Agriculture an Effective Tool for International Development
5:30pm-6:30pm	CCE 204		Informational Meeting: Reports on Regional FSR/E Symposia
7:00pm-8:00pm	Hilton Sequoyah Ballroom		Buffet & Cash Bar

Tuesday, October 10

Symposium Late Registration will continue throughout the day from 8:00am until 4:30 pm.

Time	Room	Session Number	
7:00am-8:00am	Hilton Atrium		Continental Breakfast
7:00am-8:00am	CCE 405		Asian Regional Network Breakfast
7:00am-8:00am	CCE 402		African Regional Network Breakfast
7:00am-8:00am	CCE 409		Latin America Regional Network Breakfast
7:00am-8:00am	CCE 411		U.S. Regional Network Breakfast
8:00am-8:45am	CCE 204	23	**Plenary Address:** "FSR/E and the Concepts of Sustainability" Dr. Peter Hildebrand University of Florida and Dr. Charles Francis University of Nebraska
8:45am-9:30am	CCE 204	24	**Plenary Address:** "Productivity and Profitability" Dr. John A. Miranowski United States Department of Agriculture
9:30am-10:00am	Hilton Atrium		Break
10:00am-10:45am	CCE 204	25	**Plenary Address:** "Farmer Participation in Agricultural Development" Dr. Jacqueline Ashby Centro Internacional de Agricultura Tropical, Colombia
10:45am-11:30am	CCE 204	26	**Plenary Address:** "Institutional Development" Dr. Obdulia F. Sisson University of the Philippines/Los Banos
11:30am-11:45am	Hilton Atrium		Break
11:45am-12:30pm	CCE 204	27	**Plenary Address:** "Environmental Quality" Dr. Jeffrey Leonard The World Wildlife Fund and The Conservation Foundation
12:30pm-2:00pm	Hilton Sequoyah Ballroom	28	Luncheon Regional Sessions Synthesis: Africa Asia/Near East Latin America United States

CONCURRENT GLOBAL SESSIONS

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

- *FSR/E and the Concepts of Sustainability*
- *The Role of FSR/E in Sustaining:*
  - *Productivity and Profitability*
  - *Farmer Participation in Agricultural Development*
  - *Institutional Development*
  - *Environmental Quality*
- *Special Topics*

2:00pm-3:30pm	CCE 402	29	Concepts of Sustainability
	CCE 404	30	Productivity and Profitability
	CCE 405	31	Farmer Participation
	CCE 407	32	Environmental Quality
	CCE 107	33	Panel: Women Professionals in Agriculture
	CCE 409	34	Institutional Development
3:30pm-4:00pm	CCE 2nd & 4th Floor Lobbies		Break
4:00pm-5:30pm	CCE 402	35	Concepts of Sustainability
	CCE 404	36	Productivity and Profitability
	CCE 405	37	Farmer Participation
	CCE 407	38	Panel: Access, Control and Use of Resources
	CCE 409	39	Institutional Development
	CCE 107	40	Special Topics
7:00pm-9:00pm	Hilton Sequoyah Ballroom		Poster Sessions Cash Bar

Wednesday, October 11

Time	Room	Session Number	
7:00am-8:00am	Hilton Atrium		Continental Breakfast
8:00am-9:30am	CCE 204	41	Meeting: Association for Sustainable Farming Systems Research/ Extension
9:30am-10:00am	Hilton Atrium		Break

CONCURRENT GLOBAL SESSIONS

10:00am-11:30am	CCE 402	42	Concepts of Sustainability
	CCE 404	43	Productivity and Profitability
	CCE 405	44	Farmer Participation
	CCE 107	45	Panel: Nutrition/Consumption
	CCE 409	46	Special Topics: FSR/E Methodologies
	CCE 407	47	Special Topics
11:30am-1:00pm	Open		Lunch
1:00pm-2:30pm	CCE 107	48	Panel: Methodologies for Learning About Gender and Farming Systems Research
	CCE 405	49	Special Topics
	CCE 404	50	Special Topics
2:30pm-3:00pm	CCE 2nd & 4th Floor Lobbies		Break
3:00pm-5:00pm	CCE 204	51	Global Sessions Synthesis
5:00pm	CCE 204		Program Wrap-up Adjourn

PRE- AND POST-SYMPOSIUM SHORT-COURSE OFFERINGS

SENSITIVITY TRAINING AND INTERVIEWING SKILLS
FOR FARMER PARTICIPATION RESEARCH
October 4 - 7, 1989
9:00am Wednesday through 5:00pm Saturday
Walker Room, Hilton Hotel

This four-day workshop is designed to provide on-farm research practitioners with participatory methods and the interpersonal skills needed for implementing these methods. The workshop actively involves participants in group dynamic exercises, role plays and individual self-evaluation exercises for sensitivity training. Micro-instruction and video are used to teach listening skills, probing skills and question formulation skills for interviewing. Elements of managing group interactions for participatory research are taught with practical exercises. A manual on the course (included in the fee) is provided, which draws on the experience at CIAT.
Fee: $570.00

SYSTEMS APPROACHES TO PROBLEM SOLVING IN
AGRICULTURE: THE VIEW FROM HAWKESBURY
October 5 - 7, 1989
9:00am Thursday through 5:00pm Saturday
Blossom Room, Hilton Hotel

An innovative program of agricultural education initiated ten years ago at Hawkesbury Agricultural College, now part of University of Western Sydney, Australia, has evolved into a paradigm committed to helping people in rural environments learn how to manage change and complexity. This paradigm of Systems Agriculture draws upon ideas of learning from experience and systems thinking and it aims to achieve more equitable and sustainable futures for rural communities, hence its relevance to the symposium theme of sustainable agriculture. The three day workshop will introduce participants to concepts of problems based learning and systems thinking, provide opportunity to explore learning systems in use at Hawkesbury and practice systems methodologies, explore differences between various systematic traditions in agriculture, and examine the implications of adopting systems approaches to training, research and extension and their relevance to sustainability of agriculture.
Fee: $150.00

SUSTAINABLE AGRICULTURE FIELD DAYS
Sponsored by ATTRA
October 6 and 7, 1989
8:30am Friday through 5:00pm Saturday
Albert Pike Room, Hilton Hotel

Two field days will be spent touring a variety of sustainable agriculture-related enterprises to give participants an overview of some of the work being done in the U.S. ATTRA (Appropriate Technology Transfer for Rural Areas), is a USDA Extension Service program managed by the National Center for Appropriate Technology (NCAT). ATTRA provides information and technical assistance to large or small-scale farmers, interested individuals on low input and sustainable agriculture practices and related technologies.
Fee: $150.00

EXPERT SYSTEMS AND SIMULATION
THE MODERN TOOLS FOR AGRICULTURAL RESEARCH AND
EXTENSION
October 6 - 8, 1989
9:00am Friday through 5:00pm Sunday
Business Administration, University of Arkansas Campus

This will be a limited-enrollment, intensive 3-day short course for agricultural administrators, researchers and extension specialists who want to bridge the gap between research/extension and computer use for electronic application of agricultural systems principles for technology testing and transfer. We will assess the potential for the new technologies (Expert Systems and Simulation) and explore how they can be utilized for enhancing agricultural research (including on-farm) and extension.
Fee: 550.00

WORKSHOPS FOR PRESENTERS AND FACILITATORS
October 9, 1989
Four sessions: 10:00am, 11:00am, 2:00pm, & 3:00pm

Workshop for Facilitators will focus on specific skills for integrating ideas from the various sub-themes of the conference into the discussion time following the presentations, timing presenters, and facilitating questions. First facilitator session is at 10:00am and repeated at 2:00pm.
Workshop for Presenters will focus on methods to finalize presentations and plan for effective use of time allocated for presentation. Session one is at 11:00am and repeated at 3:00pm.
Fee: No Charge

UNIVERSITY OF ARKANSAS
A LAND GRANT INSTITUTION
October 11, 1989
1:00pm - 2:30pm Wednesday

The University of Arkansas - Fayetteville is the largest of the 4 University of Arkansas campuses. As the system's flagship campus, it offers Bachelor's degrees in 113 different programs, Master's degrees in 78 and Doctorates in 21. The campus tour will highlight Old Main, the Student Union, Mullins Library, the Sports Complex, Experimental Farm, including Agronomy and Horticulture plots, Altheimer Lab, Food Sciences Complex and animal research barns. Shopping is also available in the U. of A. Razorback Shop.
Fee: $5.00

CONTINUED

PRE- AND POST-SYMPOSIUM SHORT-COURSE OFFERINGS

CONCEPTS AND COMPONENTS OF SUSTAINABLE AGRICULTURE
Sponsored by Winrock International
October 12 - 15, 1989
8:00am Thursday through 5:00pm Sunday
Yell Room, Hilton Hotel

A four-day workshop will be held at Winrock International headquarters atop Petit Jean Mountain immediately following the 9th Annual FSR/E Symposium. Surface transportation to and from Fayetteville will be provided for symposium participants. The workshop will consist of two days of classroom lectures and discussions plus a one-day field trip to Arkansas farms. A tour of Winrock International facilities and the nearby Heifer Project headquarters are also included. The objectives of the workshop will be to present the history, concepts, and terminology related to sustainable agriculture and sustainable development, discuss the interaction of crop/livestock/agroforestry research strategies in the context of natural resource management, analyze case studies from the U.S., Asia, and Africa illustrating methodologies applied and operational problems encountered, tour and review the sustainability of major Arkansas farming systems, including paddy rice, intensive poultry, cow/calf operations, and woodlot management, and brainstorm on processes to institutionalize sustainability through training, inter-institutional linkages, government/NGO interaction, regional networking, data exchange, etc.
Fee: $1,000.00

COMMUNITY RESOURCE MANAGEMENT SEMINAR WORKSHOP
October 12 - 15, 1989
9:00am Thursday through 5:00pm Sunday
Walker Room, Hilton Hotel

Community Based Resource Management is a seminar - workshop that combines practical methods for community based planning, participating skills and decision making. It includes technical knowledge and skill in utilizing communities to implement agricultural-based watershed resource projects that are sustainable. It uses a unique approach, drawing experience and insight from a variety of theoretical and practical community based information. The objectives of this course are to emphasize and deepen the understanding of the interrelated watershed resource development systems and ecological balance, to create opportunities for learning using tested approaches, schemes and strategies in Community Based Resource Management, and to share first hand experiences on how Farming Systems Research and Extension served as a conduit of development in a sustainable Integrated Watershed Research and Development Project in Southeast Asia.
Fee: $550.00

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:

- Future Symposia Committee (Program and Site)
  Chair: Harold J. McArthur
- Editorial Committee
  Chair: Cornelia B. Flora
- Finance Committee
  Chair: Robert E. Hudgens
- Constitution Drafting Committee
  Chair: Timothy J. Finan
- Nominating Committee
  Chair: Donald E. Voth

Each committee will present their report to those in attendance at the 1989 FSR/E Symposium during a plenary session scheduled for Monday morning. A follow-up meeting for questions and answers, amendments and adoption of the committee reports will be held on Wednesday morning, at which time the formal establishment of the Association is anticipated.

UNIVERSITY OF ARKANSAS FSR/E SYMPOSIUM COORDINATING STAFF

Dr. Tom Westing
Associate Dean, College of Agriculture
Director, International Agricultural Programs

Dr. Donald Voth, Symposium Chair
Acting Head, Department of Agricultural Economics and Rural Sociology

Ms. Beth Barham
Project Director/Development Officer
International Agricultural Programs

Ms. Pamela Styles
Program Coordinator
International Agricultural Programs

Ms. Nancy Christman
Special Training Course Coordinator
International Agricultural Programs

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

COORDINATORS OF REGIONAL SESSIONS

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

Asia/Near East

Dr. Harold McArthur
University of Hawaii at Manoa

Africa

Dr. Tim Finan
University of Arizona

Latin America

Dr. Peter Hildebrand
University of Florida

United States

Mr. David McNeal
Extension Service
United States Department of Agriculture

THE UNIVERSITY OF ARKANSAS

The University of Arkansas, organized under provisions of the Federal Land-Grant Act, was instituted by the 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 all 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, excluding the 14,000 students enrolled on the Fayetteville for the fall semester.

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 at 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 nonformal training, communication, development assistance, and resource mobilization.

Winrock has more than 225 staff member, 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.

FARMING SYSTEMS RESEARCH/EXTENSION PAPER SERIES – ORDER FORM

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Manhattan, Kansas 66505, U.S.A.

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3.	The Farming Systems Approach to Research (by David W. Norman) and Farming Systems Research and the Land-Grant System: Transferring Assumptions Overseas (by Cornelia Butler Flora)(October 1982 - FSR Background Papers)	_____	$5.00	_____	$0.50	$_____
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11.	Farming Systems Research and Extension: Management and Methodology (Peer reviewed selections from papers given at Kansas State University 1985 Farming Systems Research Symposium). Edited by Cornelia Butler Flora and Martha Tomecek (August 1985)	_____	$15.00	Microfiche Unavailable		$_____
12.	Farming Systems Research and Extension: Food and Feed - Abstracts (1986 Symposium Abstracts). Edited by Cornelia Butler Flora and Martha Tomecek (October 1986)	Out of print		Microfiche Unavailable		
13.	Selected Proceedings of Kansas State University's 1986 Farming Systems Research and Extension Symposium: Food and Feed. Edited by Cornelia Butler Flora and Martha Tomecek	Out of Print		Microfiche Unavailable		

13a.	Addendum to Selected Proceedings of Kansas State University's 1986 Farming Systems Research and Extension Symposium: Food and Feed. Edited by Cornelia Butler Flora and Martha Tomecek	**Out of Print**		Microfiche Unavailable	
14.	How Systems Work: Farming Systems Research Symposium 1987 - Abstracts (October 1987)	_____	$9.00	Microfiche Unavailable	$_____
15.	How Systems Work: Proceedings of Farming Systems Research Symposium 1987 (October 1987)	_____	$25.00	Microfiche Unavailable	$_____
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ABSTRACTS

SYMPOSIUM KEYNOTE ADDRESS <1

Mohan Man Sainju
Royal Kingdom of Nepal
Ambassador to the United States

REGIONAL SESSION: AFRICA

THE ROLE OF FARMING SYSTEMS IN SUSTAINING PRODUCTIVITY AND PROFITABILITY OF SMALL FARM HOUSEHOLDS IN KENYA: A CASE STUDY OF KWALE AND NAKURU DISTRICTS <2

Benjamin Acquah, Feyisa Demie

As part of the preparation for a project to be funded by UNDP to enable Egerton University to initiate an extension outreach program in Small Farming Systems development, a baseline survey was conducted in Kenya in January and February, 1989 in Kwale and Nakuru districts respectively. The objective of the baseline survey was to obtain socio-economic information on farming systems in Kwale and Nakuru districts in order to have a reference point when analysing the performance of the project after a period of operation. The methodology used inthes urvey included the use of random sampling to select farm households, personal interview method for collecting information from respondents, and cross tabulations and descriptive statistics as methods of anlysis of the survey data.

The findings of the survey indicated that while the farming system in Kwale district was based on tree crop and livestock production, that Nakuru district was based on the prodution of cereals, beans, and dairy. Factors having an adverse effect on productivity and profitability in the two districts included lack of adoption of improved technology and use of credit, problems of marketing lack of access to extension services, and knowledge outside the farming system, and the process of decision making within small farm households.

The study showed that farming systems research and extension have an important role to play in helping to identify the factors that need to be examined effectively within small farming systems in order to sustain productivity and profitability of the Farming Systems in Kwale and Nakuru districts, respectively in Kenya.

ANALYZING FARMING SYSTEMS RESEARCH AND EXTENSION RESULTS UNDER UNCERTAINTY: A STOCHASTIC PROGRAMMING APPROACH IN NIGER <3

Akinwumi Adesina, John Sanders

The problem of low agricultural output besets most of the production systems in West-African Semi-Arid Tropics (WASAT) and numerous technical possibilities have been suggested to reverse the growing trend. These vary from introduction of improved varieties which are resistant to biotic and abiotic stresses, increased us of chemical fertilizers, better soil and water management practices, improved cultural practices (i.e. weeding, minimum tillage, alternative planting dates), agroforestry and crop-livestock interactions. The experience of several farming systems programs in WASAT have shown that the adoption rates of many of the proposed technologies are low.

The crucial role played by economists in analyzing the impacts of the farming systems research and extension (FSR/E) results has mainly been in (a) identifying the potentials and constraints to increased productivity of current farming systems, (b) conducting collaborative on-farm trials on potential technology interventions, (c) assessing the farm-level impacts of the technologies and (d) identifying the potential constraints to the successful introduction of these technologies. Methodologies used in this economic analysis ranges from partial budgets to simple linear programming whole farm models. however, several of the economic analysis of FSR/E results in WASAT have not looked at their farm-level impacts under several rainfall patterns and they have mostly been based upon "average" rainfall situation. Moreover, given the erratic rainfall patterns characteristic of the WASAT, research planners are not interested in performance under average rainfall scenario but under alternative rainfall scenarios. Uncertainties in cereal pricing policies also dictate that analysis of the impacts of FSR/E results in WASAT be conducted with attention paid to stochastic production and economic factors constraining the farming systems.

This paper presents the use of a novel approach to analyzing the economic impacts of FSR/E results within the stochastic environment faces by WASAT peasant farmers. The methodology used in this paper is discrete stochastic programming (DSP). The method allows decision makers to take sequential decisions and to adapt to the stochastic events affecting their decisions. The method has several advantages over the traditional methods which has characterized previous FSR/E research. Especially important is the ability to analyze results of farm-level impacts of proposed and current technologies in alternative weather and price patterns. While this approach has been used in developed agriculture, no study in Sahelian West Africa has applied the methodology to analysis of FSR/E results.

The DSP methodology is used to analyze the farm-level economic impacts of agricultural technologies developed for the Sahelian region of Niger. using long term rainfall data, we categorized rainfall states into five alternative patterns under which the farm level impact were analyzed. The rainfall patterns are categorized as "very good" (> 594 mm/year), "good" (484 - 594 mm/year), "normal" (350 - 483 mm/year), "poor" (267 - 349 mm/year) and "very poor" (< 267 mm/year). Probabilities of these states of nature are specified. The technologies analyzed consist of traditional farmer technology, introduction of improved cereal varieties and improved agronomy technology consisting of combining improved varieties with other agronomic practices. Several years of farm-level and experiment station data form the rich database upon which the analysis is performed.

The paper shows that despite the adoption of agricultural technologies, farmers productivity shows substantial variability between rainfall states under each technology option. Return to rainfed agriculture also show substantial variability under each weather state and technology option. Estimates of cash and total income returns to labor under each alternative rainfall pattern and technology choice are provided.

Computed productivity indices show that farmers are insufficient in cereal production and consumption in the "normal", "poor" and "very poor" rainfall situations. However, farmers were self-sufficient in cereal production in the "very good" and "good" states of nature. Comparisons are made between the productivity indices under the alternative technologies and farmers depletion of livestock assets in order to cope with cereal deficits under the relevant deficit rainfall situations. Since cereal price collapses are common in the WASAT during good rainfall years when farmers have more grains to sell, we analyzed the implications of alternative price floor intervention policies for cereals on the returns to investment in the alternative technologies. The paper draws implications for the direction of agricultural programs in the Sahelian region of Niger in order to

stabilize yields and incomes to agriculture on a sustainable basis.

4> FARMERS'S APPROACHES TO SOIL QUALITY MAINTENANCE UNDER REDUCED FALLOWS

Susan Almy, Tsegazeab Woldetatios, Comfort Ateh

The principal problem of agricultural sustainability in Africa is the lack of adequate technologies for maintaining soil quality after long fallows are abandoned. Reduced fallows have led to increased nutrient depletion rate, erosion, changes in texture, increases in insect pest populations and in crop diseases.

A variety of solutions, most derived from European agriculture, have been proposed, including legume intercropping, crop rotation, contour farming, and alley cropping. However, experience shows a slow response by farmers to agronomic cultural practice recommendations, a category which necessarily includes soil maintenance practices.

The Farming Systems Research and Extension approach has brought the researcher face to face with these developing problems, and with the farmers' disinterest in most cultural practice solutions. To overcome this disinterest, the farmers must be brought into the process of developing the solutions, and as a beginning, the problem and attempts at solution must be understood from their perspective. Only then can new or altered practices be suggested that will better the farm environment without increasing the farmers' constraints.

The Testing and Liaison Unit at Ekona, an FSR/E unit in the national agricultural research system (IRA) of Cameroon, works in the high-rainfall coastal lowlands, particularly South West Province (SWP). SWP contains a complex mix of soils types, rainfall gradients, altitude ranges, and farming population densities. Average fallows vary from 1.4 to 5.1 years in the different zones. Many of these zones contain large numbers of immigrant farmers trained to different cultural practices. The diversity makes an ideal laboratory for the study of farmers' approaches to maintaining soil quality.

In 1989, the TLU began a study of farmers' land preparation and weeding practices in the four most important lowland zones of the province: Lower Volcanic (LV), Kumba Corridor (KC), Sands and Mamfe. The methods used include a series of multidisciplinary short visits to farms to observe and discuss work in situ throughout the year; monitoring of weed growth and weeding time and methods; chemical soil analysis of the mounds and alleys of newly prepared fields; and weed identification. Special attention was given to residue management and regeneration of fallow. At the same time, introductory trials have been going on on-station in alley cropping and legume-cereal-tuber associations.

SWP is a multiple-staple region, with most farmers growing plantains, cocoyams, maize, cassava, and sometimes yams. Almost all lowland farmers grow cocoa. There are two growing seasons in most of the region, with a short second season possible in the rest. Throughout the province, cocoa, oil palms and plantains are the primary responsibility of the men, and other food crops, of the women. Oil palms and plantains are scattered through both food and cocoa fields.

The LV zone is a new volcanic, highly fertile soil, farmed by immigrants from the Highlands, where intensive intercropping on beds is common; in the LV, they plant mostly on flat. KC is mostly old volcanic, a heavier, medium-fertility soil, farmed by highland immigrants and local farmers with intensive intercropping on beds inside cocoa fields. The Sands compose two sub-zones of low-fertility, sandy clay loam sediments, one with short fallows, a lowland immigrant population and mound intercropping; the other with high rainfall, longer fallows, indigenous farmers and mixed cropping on flat. Mamfe zone is granitic, low-fertility and acidic, and has a purely indigenous population, long fallows and intensive intercropping on mounds.

South West farmer differentiate between four types of growing matter on their fields: sticks, strong grass, soft grass and chop. Sticks are trees, living or felled; strong grass is woody-stemmed shrubs, small branches and very hard leaves; soft grass is any non-woody weed; and chop is food plants. This classification guides their treatment of plants.

Preliminary results indicate that one factor common to all zones is the continuing presence of small trees throughout most food fields, at densities of 300 up to 1200 plants per hectare. Farmers reduce the competition with crops by cutting them off at the base and hacking off resprouting leaves during weeding episodes. The stump and root system remain alive and regenerate young 1-3m trees during a 3-4 year fallow, or bushy clumps of leaves during a 3-12 month fallow. Some farmers in all zones try to destroy all established saplings by intensive burning and uprooting, and in short-fallow fields succeed in eliminating them.

Weed management at land preparation is of four types: clearing from the field, burning, surface mulching, and incorporating in beds or mounds.

Only about half of the farmers in the KC and Mamfe zones only practice incorporation. LV and Sands farmers feel that their soft grass (elephant grass (related to guinea grass) and pueraria (a leguminous cover crop)) competes too strongly with the crops, resprouting from inside mounds and blocking tuber development. In KC farmers with the same weed combination (usually pueraria and short grass) may choose to incorporate it or burn it; inhabitants of highland-origin villages usually incorporate. In Mamfe, the dominant weed is a tall, withy, prolific bush (Asteraceae, probably *Chromolaena odorata*), and must be well minced to rot enough to allow good tuber formation. Southern Mamfe farmers, with better decomposition and a greater preference for shallow-rooted crops, usually incorporate, while northern ones do not, and most incorporate soft grass if the bush is not much.

Surface mulching is practiced: (1) where good elephant grass fallow has been established; it is cut during the height of the rains and the crops planted through it, to suppress further weeds. (2) in forested zones tuber crops are mulched during weeding to deter wild animals from digging them up.

Burning is practiced by almost all farmers. Those who mulch or incorporate also gather sticks, hard stems, some obnoxious weeds, and old crop residues, and burn them in heaps, often around trees they want to kill or strip of leaves. The rest cut down all the fallow growth, let it dry and set fire to the field. LV, Sands and KC fields are often only partially covered with ash owing to irregular burning.

Clearing the weeds from the field is a strategy for wet-season planting only, practiced by those who do not incorporate because they fear bad effects as noted above.

5> FARMING SYSTEMS APPROACH TO SMALL-SCALE FARMERS' PERCEPTIONS ON GRAIN LOSS IN KENYA

Judith Bahemuka-Mbula

Post-harvest grain losses are a considerable drain on food available for both marketing and home consumption. Within Kenya, much thinking has been put into post harvest food losses and food practices. The Kenya National Agricultural Laboratories have done extensive researches trying to quantify the amount of loss experienced by small-scale farmers. The figure mentioned for post harvest grain losses varies widely from 6% to 16%. Actual losses also vary from year to year as a result of climatic conditions.

The problem of grain losses has become more serious over recent years as a result of changes in farming practices. Hybrid maize was an important break through in crop production during the late sixties and the early 1970's. The new grain varieties, however, while producing far higher yields than the traditional varieties are also more susceptible to attacks from insects and molds. Thus, they require improved drying and storage facilities for more production. The aim of the Kenya Government is to reduce grain loss by fifty percent by the year 1990.

The On-Farm Grain Storage Project:

In 1980, Development Planning and Research Associates, Inc. (DPRA) completed a seven-month study entitled, *Kenya National Crop Storage Study.*

This study, sponsored by the United States Agency for International Development, for the Ministry of Agriculture, Kenya Government, led to the current Project focussing on on-farm grain drying and storage for the smallholders in Western Kenya. The Project seeks to increase the use of more effective on-farm grain drying and storage practices by smallholders in Kenya.

A survey was undertaken as one activity of the On-Farm Grain Storage Project to determine post-harvest management practices, to examine farmers perceptions, and constraints to the introduction and promotion of on-farm grain drying and storage technology and to analyze and identify factors associated with the adoption of technology. Strategies for the dissemination and administration of storage technology to smallholder farmers, the target group for the On-Farm Grain Storage Project, were noted.

The Information Base:

The study incorporated data gathered from several case studies, women groups in Kenya, extension officers and farmers. The farmer respondents were drawn from the Western Kenya, the Rift Valley and the Eastern and Central Provinces. So far, the researchers has interviewed over two thousand small-scale farmers. This figure includes the 850 farmers interviewed in 1984 in Western Kenya.

The Findings:

One of the neglected areas in grain storage is the question of how much farmers know about grain loss and management practices. Throughout the surveys (undertaken in 1984-85, 1986-87, 1988-89) farmers were asked to define grain loss, how much grain is lost during harvesting, transportation, drying, storage, etc.

Farmers reported that grain loss is seen as that grain eaten by birds, insects, rodents and spillage. Other items mentioned included animals, thieves, breakages, and molds. The major cause of grain loss was seen as spillage during harvest, animal and bird consumption during drying; insects and rodents during storage. Theft of grain was sometimes reported before harvest or during drying, but mostly after storage.

To protect grain from insects, rodents, fungi and mold farmers reported the use of insecticide, ash treatment, cow dung, cats, traps, poison, rat guards, clearing of grass around the stores and grain drying. Over fifty percent reported traditional ash treatment and 2 percent reported drying grain before storage. Loss from rodents was prevented by the use of traps, poison, rat guards and cats.

Most farmer argued that grain eaten by the animals and birds (chicken) was not lost since these animals were part of the system. in fact once Women Group in the Trans Nzoia District of Rift Valley felt that they should share the grain with weevils because that was inter-dependence.

Conclusion:

For the last five years, the researcher has been looking at the farm system in Kenya to try and understand farmers' perceptions in the area of grain storage. It is an area that should be encouraged in all developing countries.

SUSTAINABILITY OF RESEARCH SYSTEMS: DEVELOPMENT AND FSR/E PORTFOLIO APPROACH IN CAMEROON <6

Doyle Baker, John Poku

Sustainability has become an important FSR/E issue in large part because many national agricultural research programs focus on short run productivity gains. Perhaps most of the mechanical and biochemical technologies developed to increase productivity have resulted in accelerated environmental "mining" and, in extreme cases, ecological destabilization.

Thus far, the concept of sustainability in FSR/E has been taken to mean a refocusing on ecologically sound technologies such as alley cropping or cover crops for biological weed control. This paper:

a) proposes a broader concept of sustainability;
b) argues that sustaining productivity requires an FSR/E portfolio encompassing a range of activities; and
c) gives an example of a portfolio approach based on experiences in the Centre Province, Cameroon

The concept of sustainability developed in the paper focuses on the sustainability of agricultural research systems. Agricultural research, including FSR/E, is an investment with opportunity costs. Research systems can sustain productivity increases only if research themes and specific operations:

a) have high economic returns, and
b) correspond to the national development priorities.

Thus, to make sustainable contributions, design of an FSR/E program must start with an assessment of the expected benefits from various research/extension investments defined in relation to national priorities. This can be done using the "parity" research resource allocation model popularized by Ruttan and Hyami. Some factors considered in a parity assessment are:

a) roles of various commodities in the national economy;
b) investment and time required to develop a technology;
c) pattern and pace of adoption under various policy, institutional and infrastructural circumstances; and
d) likely benefits and costs per adopter.

On the basis of a parity assessment, research domains and priorities can be established, and specific operations can be designed which efficiently use available research and extension resources. The basic economic principle of equating expected marginal value products in order to maximize returns can then be used to define an optimum portfolio of activities.

A portfolio of operations defined on the basis of a parity assessment almost certainly will result in more sustainable productivity increases than will an ecological concept of sustainability because:

a) chances are increased that returns to resources will be sufficient to justify on-going investments in research and extension, and
b) priorities are defined in relation to a range of development goals which are important to a range of decision makers rather than in relation to one specific development objectives.

After characterizing relationships between sustainability, parity, and FSR/E portfolios, the paper presents a concrete example based on recent activities of an FSR/E "Testing and Liaison Unit" working in the Centre Province, Cameroon. A portfolio is in place in the Centre Province and the FSR/E concept of iteration is being applied to elements of the portfolio as well as to specific operations.

LAND USE, TOPOGRAPHY AND SUSTAINABLE AGRICULTURE IN RWANDA <7

Daniel C. Clay, L.A. Lewis

The conservation of scarce land resources is crucial to the long-term viability of agriculture in Rwanda. High population density, steep slopes and abundant rainfall prevail in this highland African country and as a result make the task of erosion control uncommonly difficult. The particular use to which land is put (e.g., cultivation, fallow, pasture, wood-lot), and if it is cultivated, the particular combination of crops grown, can be seen as contributing to both the cause and the solution of the erosion problem. Based on data from a nationwide survey of over 18,000 agricultural fields in Rwanda, this study reviews the extent to which the land use and

cropping patterns employed by farmers are appropriately suited, in terms of erosion control, to the topographical and climatological characteristics of their landholdings. Analyses of other aspects of the traditional agricultural system, e.g., variations in relative soil fertility, land tenure patterns, and the location of fields relative to the household, are introduced to help explain why farmers often fail to maximize erosion control through land use and cropping practices. Adjustments to current land use practices that can be expected to reduce soil loss are discussed.

8> LES ATELIERS REGIONAUX DE RECHERCHE: A NEW TOOL FOR SUSTAINING FARMER PARTICIPATION IN AGRICULTURAL DEVELOPMENT IN BURUNDI

Bernard Delaine

One of the major impetus for advocating the farming system approach was the realization that farmers could contribute substantially to the identification, development and evaluation of relevant improved technologies; in other words, that they are full partners to researchers and extension agents in the process of agricultural development. But to achieve farmer participation in all stages of research requires intimate farmer involvement in the processes of understanding existing systems, diagnosing their problems and constraints, designing solution, testing them and extending them to the farming community. In the design process, if farming system researchers recognize the complementarily of on-farm research and on-station research, the challenge is still to make the two-way linkage effective. As D. Norman puts it: "In general, station-based researchers have found the link from them to the farming systems teams (which select technologies off the shelf) less threatening than the link in the opposite direction (in which farming systems teams help determine on-station research priorities)".

This situation is true in Burundi, where a new structure of ISABU is underway, after the realization that few results of the research stations have been extended to and adopted by the farmers. This is due to a number of shortcomings such as "a limited knowledge and understanding of the production systems; an inadequate research-extension-farmer link; the lack of interdisciplinary research and a problem of research applicability at the farm level". (Diagnostic 1989)

A study of ISABU conducted by ISNAR confirms these shortcomings when it states that "In-depth knowledge of most aspects of the farmer's reality is quite insufficient. On-station research is necessary but cannot test the economic and social parameters governing adoption...opening onto the real constraints of the rural areas is both the goal and a tool of the reorientation of research at ISABU". (ISNAR P.12)

This tool for reorienting research will be the "ateliers regionaux de recherche" (research workshops), which are based on the assumption that "deficiencies in program conception can be surmounted by a better exchange of information between researchers and farmers via extension, and through more direct work of researchers in a real farm situation". (ISNAR P.12) Therefore, in a country like Burundi, to improve the effectiveness of research in responding to farmers' needs, three approaches must be combined: (1) the acquisition of a better knowledge of farmers needs and characteristics as well as of their environment; (2) the determination of the technological priorities in relation to their urgency, feasibility, cost and to national directives concerning agricultural development; (3) the conduct of research activities as such. These are the logical sequences which lead ISABU to formulate this new concept of "ateliers de recherche", which will tackle these processes at once, since they organize research in a real life environment.

The "ateliers regionaux" represent a new approach at two levels: it is a new way of conducting agricultural research in general and it is a new way of undertaking research at the farm level.

It is a new method for research since it assumes that technical as well as socio-economic constraints cannot be apprehended only on-station research. The baseline hypothesis is that the "ateliers" are a mean to get the necessary understanding to overcome the main constraints to the problems of technology transfer.

It is also a new way of undertaking research at the farm level, in that it is expected that the ateliers will provide a better understanding of the technical conditions and socio-economic environment, without trying to control them. The objectives will then be to develop new technologies which have the best chances of being adopted by farmers.

From the methodological point of view, the starting point for these ateliers is the execution of a diagnostic survey in order to find out the farm's needs and constraints. It is followed by sectorial meetings to get a direct feed back from the farmers about their problems and to have them prioritize these problems and constraints. Most of the time, new problems are mentioned, which were not discovered at first by the researchers during the diagnostic survey. The prioritization of these problems serve as a basis for the plan of work to be developed by the ateliers. These problems and constraints (the demand) are confronted with the technologies offered by the researchers (the offer), so that research will be reoriented to fit with the demand.

It is expected that through this new structure, the researchers will get an in-depth understanding of the prevailing farming systems in the area as well as of the technical and socio-economic conditions of the farmers so that the new technologies proposed will respond more directly to farmers' needs in their specific agro-ecological environment.

If successfully implemented this new structure of ISABU will reinforce the linkage from farming systems teams and the station based researchers and from the farming system teams and the farmers. It will foster the necessary steps in sustaining farmers participation in Burundi's agricultural development.

9> EXPERIENCE OF MOROCCO IN ESTABLISHING A LOCAL NET WORK: RESEARCH - FARMERS - EXTENSION

E. El M'zouri, M. Mazhar, L. Edwards

Agricultural research and extension are in two separate institutions in Morocco. The headquarters of both institutions are localized in the capital, Rabat, and have regional offices in different ecological regions of the country.

Within each region, research people have a tendency to conduct most of their trials on their own field station rather than on private farms. The results are communicated to the extension headquarters in Rabat through reports. Only a few bulletins, brochures and leaflets for farmers have been published by I.N.R.A. (Institut National de la Recherche Agronomique) during the last few years.

The extension services, while publishing some bulletins and using media to inform farmers about actual events, provide leadership for national crop operations, not necessarily supported by research findings. People at higher levels of government send orders to the local extension agents to apply these programs without taking into consideration the people's level of knowledge or capability.

The farmer from his side feels that neither research nor extension invites him to contribute to the decision making process while establishing research and extension programs.

So the absence of communications and contacts between research and extension on the one hand and the absence of involvement of farmers in decision making on the other hand creates the gaps between these organizations.

To try to reduce these gaps at the local level, we developed a methodology for developing and improving working relationships between research, extension and farmers of the Settat province of Morocco.

First of all, we (a technology transfer team within INRA) started collaboration with the local extension agents and local farmers at a preliminary meeting. Together, we identified the farmers needs and

the appropriated technologies to respond to his needs. We had closer contacts and cooperative work at the planting stage. Subsequently, official meetings between the local decision makers, the agricultural development services and agencies, the regional research center and farmer representatives were held to promote this research- extension - farmer network. After sufficient input from all interested groups including the farmers, we installed on farm trials on 6 farms.

Each trial consisted of 5 barley, 10 durum wheat, and 4 bread wheat varieties together with a package of research- farmer-extension recommended cultural practices for that particular farm. We compared these cultural practice combination with a complete farmer managed plot.

Over 25 field tours were organized with farmers and extension agents. Local and national decision makers also visited the on farm trials as well as the regional research center and the experiment stations.

These events have shown us a promising future for agricultural development in the region.

At this stage the national headquarters, at the capital Rabat, are convinced that the local extension- research programs should be developed by the regional representatives of the two institutions with maximum farmer input.

This research - extension - farmer network, developed in the Settat Province, will help to build strong, stable, efficient and sustainable institutional structures for both local and national agriculture.

SUSTAINING SOIL FERTILITY WITH ALLEYCROPPING IN MOUNTAINOUS REGIONS <10

Val J. Eylands, Charles Yamoah

The Farming Systems Research Project in Rwanda is implemented by the University of Arkansas and is now in its fifth year. The FSRP work area covers four communes in northern Rwanda. The topography is mountainous, with field slopes ranging between 10 and 100%. As Africa's most densely populated country, Rwanda experiences extreme land pressure, and hills are cultivated from valleys to hillcrest. The highland region receives 1200mm of rainfall each year, distributed in two rainy season. Due to the severe slopes and lack of erosion control, topsoil losses can approach 300 MT/ha/yr.

Early diagnostic surveys identified declining soil and fertility due to erosional losses as the primary constraint to sustained production. Following alleycropping and terracing strategies developed by IITA and ICRAF, early project work focussed on on-station and on-farm screening of leguminous trees suitable for an alleycropping system that would slow erosional losses and provide nitrogen-rich biomass for incorporation into the soil.

Three species were identified as appropriate for the Rwandan highland conditions. Sesbania, leucaena, and caliandra all met the criteria of being easy to establish, coppicing well after pruning, and of being able to produce substantial amounts of biomass for use as green manure of forage. Farmer feedback indicated that in addition to erosion control, the ability to produce poles for growing the higher-yielding climbing beans was also a priority.

The objective of the alleycropping research was to close the nutrient cycle so as to attain a low-input system that would sustain soil fertility. The nutrient loop at present is very open-ended, with nutrients exiting the system through erosion, leaching, and crop residue removal. No chemical fertilizers are used in the area, nutrient inputs to the loop being confined to small quantities of manure added to priority crops, mainly beans.

The trees alone immediately contributed to closing the loop by slowing erosional losses and reviving leached cations through extensive rooting systems. Erosional losses remained high, however, as fields are unprotected for several months each year. As a result, a green manure relay crop of vetch was introduced to the system, providing cover between seasons, adding additional N and OM to the soil, and increasing recycling efficiency.

Because soils of the region are highly-weathered Oxysols, soil acidity is a problem, and most soils are deficient in Ca and Mg, and often P and K are low as well. Even if the nutrient loop were completely closed, crop yields would remain poor until lime was added to the system. Lime adds the necessary Ca and Mg and frees Albound P, leaving only K lacking in some soils.

Once established, sesbania on-farm was yielding an average on 5 MT/ha/yr biomass with one pruning. When combined with a 2 MT/ha dry matter yield of relay-cropped vetch, the two legumes were adding 182kg N/ha annually, as well as recycling 32, 70, 121, and 15 kg/ha/yr of P, K, Ca, and Mg, respectively.
Acceptance of the treed terraces has been high, and presently one experiment station, four communal, and 27 on-farm tree nurseries provide close to one million seedlings annually for area farmers. Soil fertility is building in those fields where the three-part system of leguminous trees, relay-cropped vetch and lime is used, along with the normal rates of manure used by farmers. Many questions remain unanswered, but much progress has been made towards closing the nutrient loop and providing Rwandan farmers with a system capable of sustaining soil fertility.

EFFECTIVE INTEREST RATE: ITS IMPACT UPON AGRONOMIC TRIAL RESULTS, POLICY DECISIONS AND THE INDEBTED PRODUCER <11

Tom Gillard-Byers, Doyle Kalumbi

Economic activity in Malawi is dominated by the agricultural sector. The agricultural sector employs 85% of the labor force, produces 37% of the GNP and accounts for 90% of export earnings. The structure of Malawi's agriculture is diversified with two main producers' groups namely the smallholder and the estate.

Among factors limiting smallholder productivity is a lack of resources for input purchases. About 70% of smallholder farmers, nationwide, do not have adequate resources to purchase inputs such as fertilizer. This being the case, government credit for the purchase of inputs has been a major component of past and present rural development programs.

The credit system is distinguished by the exclusive use of farmers' clubs as the channel for in-kind credit. Despite the role of credit in agricultural development, consensus does not exist with regard to the actual cost of capital.

A census of farmers participating in the Malawi Adaptive Research Program (ARP) on-farm agronomic trials was undertaken using the CIMMYT farming systems methodology, adapted for the needs of the ARP. The results of the census are utilized in estimating the effective interest rate associated with government credit. The main thrust of the activity is the generation of appropriate coefficients for use in economic analysis of on-farm agronomic trials. Without proper coefficients for inclusion in this analysis each agronomic technology recommended is overvalued. This may result in the dissemination of technologies which are not viable. In addition, the coefficients may have broader implications for evaluation of government policy relative to smallholder credit.

The paper will show that the divergence between stated government interests rates and the effective interest rate for smallholder credit results in additional costs being incurred by producers receiving credit. The results indicate that the smallholder producer finds it more difficult than before to break away from the "vicious cycle" even though credit is available.

The authors will provide documentation that the divergence between the official interest rate and the effective interest rate results in repayment opportunities which vary across Agricultural Development Division. (These are the eight technical and administrative divisions in Malawi for agricultural extension.) Repayment opportunities reflect, indirectly, the risk faced by producers in one area relative to another.

Options for improving credit alternatives will be addressed. The paper will discuss the need for reevaluating the present interest rate structure as it impacts upon the smallholder. In addition, the effect which this restructuring may have on the analysis of agronomic trial data within the Adaptive Research Program will be discussed.

In summary, proper interest coefficients, incorporated in the economic analysis of agronomic trials, ensure more viable technology generation. Cost of capital estimates will be improved through continued producer, extension and researcher interaction during on-farm research and extension activities. Furthermore, options from which policy makers may choose are discussed. The choices which result may determine how easily the Malawi producers move away from subsistence/cash farming into more commercial endeavors.

12> SUSTAINABILITY OF TECHNOLOGIES DEVELOPED THROUGH FSR: THE CASE OF MILLET AND COWPEAS IN NIGER

Germaine Ibro, J. Lowenberg-DeBoer, K.C. Reddy

As was the case in many other farming systems research (FSR) programs, the FSR program at the National Agronomic Research Institute of Niger (INRAN) was not developed with sustainability as an explicit goal. Concerns for the long term viability of introduced technologies, environmental effects and macroeconomic repercussions were present, but in the background. The immediate needs for food and profitable activities for a population impoverished by drought were pressing. As a consequence, data gathering and analysis has focused on agronomic and microeconomic aspects. The objective of this paper is to analyze the millet and cowpea research program from the stand point of sustainability using currently available information and to outline the data needs for a more complete analysis.

For this analysis sustainability is defined as the ability of a system to function for at least several generations without serious deterioration in the environment or major disruption of the economic and social spheres. Following Lowrance et al. the analysis will be organized according to a spatial hierarchy: agronomic sustainability, the field level; microeconomic sustainability, the farm level; ecological sustainability, the watershed or other area defined by geographic and biological features; and macroeconomic sustainability, national or regional level.

The technologies included in the INRAN FSR program for millet and cowpea intercrop include: traditional methods (T1); improved varieties with traditional cultural practices (T2); improved varieties with higher plant density (T3); improved varieties, higher density and fertilizer (T4); and improved varieties, higher density, fertilizer and insecticide (T5). Short run analyses indicate that T4 and T5 show promise in the higher rainfall areas, but only T2 is consistently profitable for the lower rainfall site (Maliki et al.).

At the field level, the ability of a package of farming practices to maintain productivity over time is closely linked to the changes in soil conditions. The INRAN FSR program has regularly soil tested trail plots, but it has collected no data related to soil changes over time. In fact, the program has specifically sought new fields each year to avoid complicating the analysis with carryover effects. A biological simulation model has been used to examine the long run yield potentials of the tested technologies (Lowenberg-DeBoer et al.). Soil dynamics were not included in those model because of lack of data.

The soil tests at the INRAN on farm trial sites indicate that the "dune" soils used for millet and cowpeas are very sandy, low fertility and acid. On the negative side, the nitrogen fertilizer in T5 has the potential for increasing soil acidity. The technologies do not address the soil erosion problem. On the positive side, phosphate fertilization (T4,T5) may increase soil fertility over time and permit a reduction in fertilizer applications. Soil test and yield data for several years and several sites under continuous cropping using the proposed technologies is the minimum data need for a more complete analysis. With modification for soil dynamics the existing simulation model could be used to estimate the long run consequences of the technologies.

Consistent with the original objectives of the INRAN FSR program; the microeconomic sustainability of the tested technologies has been studied relatively thoroughly. The issues examined include: labor bottlenecks, capital requirements and risk. The new technologies increase the variability of yields, but analyses indicate that is primarily due to higher yields in the years of good rainfall. The most promising technologies consistently out yield traditional practices (Lowenber-DeBoer et al.). The capital problem could be at least partially solved with appropriate input supply programs (Krause et al.).

The long term profitability and ecological sustainability of the technologies developed and tested by INRAN are linked closely to macroeconomic aspects. For example, if the INRAN technologies were widely adopted, millet yields could be approximately doubled. Niger currently produces most of its cereal needs. Though shortages occur in low rainfall years, the domestic market is glutted in years of good rainfall and millet prices fall sharply. Export markets for millet are not well developed and do not show great promise. Thus adoption of the new technologies could force substantial changes in land use and production patterns. Some land might be returned to grazing use. The market for Nigerien livestock is well developed and growing. Alternatively, production of cowpeas or other crops with greater market potential might be intensified. Market analysis indicates that the market for cowpeas in Nigeria could absorb a substantial increase in exports from Niger (Gadbois and Rassas).

Because T4 and T5 use imported fertilizer and insecticide, the widespread adoption of these technologies could also pose foreign exchange problems. Niger has phosphate deposits and technology exists which would permit the country to supply its own phosphate fertilizer needs, but importation of nitrogen fertilizer and insecticide seems likely for the foreseeable future.

In short, widespread adoption of the proposed millet and cowpea technologies would have major repercussions on the Nigerien economy. In one way or the other, the country would have to adapt to the new situation, but the type and stability of the new equilibrium is not obvious. The dependence of many solutions on exports markets in Nigeria and the potential instability of the Nigerian market suggests that the new equilibrium might be unstable.

The data and analysis needs to access the macroeconomic sustainability are major. Data on the development of demand for food and feed grains n West Africa are needed. In niger little is known about the basic characteristics of food demand. In analyzing the effect of changing farming systems on national and regional economic and social patterns, modeling is likely to be an important tool of analysis. Experimentation with nations is expensive and dangerous.

The focus of the INRAN FSR program has been to increase farmer productivity and income. Thus it is not surprising that the microeconomic sustainability and the data collection system for assessing this type of sustainability are relatively well established. More questions exist on the other aspects of sustainability. Basic data for assessing the effect of new agronomic practices on soil conditions have not been collected. The widespread use of nitrogen fertilizer and insecticides raise the possibility of contamination of water and food. Widespread adoption of the proposed technologies would require major changes in the national economy, but relatively little research has been done on ways to deal with these problems.

13> FROM RESEARCH DOMAINS TO RECOMMENDATION DOMAINS: USING ECONOMIC PARAMETERS TO REDEFINE TARGET ZONES FDR TECHNOLOGY TRANSFER IN SOUTH-WEST MOROCCO

Abdelali Laamari, Giles T. Rafsnider

In Morocco many organizations and institutions are increasingly concerned width technology transfer and extension. The National

Agronomic Research Institute (INRA) has recently launched an on-farm trial program in an attempt to determine the transferability of on-shelf technologies developed by on-station researchers. To do so, INRA researchers have defined a first set of research domains in the Abda and Chaouia regions, in the arid and semi-arid zones of western Morocco. both diagnostic and verification trials have been implanted in those two research domains. Simultaneously, agricultural economists have surveyed 290 farms disseminated in the two research domains. This baseline survey has permitted the stratification of farms following resource endowment and economic criteria. Resource endowment criteria are size of farm and tractor ownership. Net returns per ha were calculated and averaged by farm size and tractor ownership. Custom farm work was also considered. Farmers were also stratified in accordance to the type and level of technology utilized.

Resource endowment nd economic criteria have allowed agricultural economists to subdivide research domains into recommendation domains in which to further conduct both scientist-managed on-farm trials. Once INRA technologies have been tested and verified in these newly redefined recommendation domains, recommendations may be targeted more precisely. The analysis shows that access to land and tractors is strongly correlated with the type of technology proposed by on-station researchers.

MEASUREMENTS OF ECONOMIC SUSTAINABILITY IN CAPE VERDE <14

Mark Langworthy, James Wade

This paper will propose a working definition of an economically sustainable agricultural system, discuss the merits of such a definition within the context of Farming Systems Research, and provide an example of application of the concept in the Cape Verde Islands. The standard economic definition o a sustainable activity is based on the notion of opportunity cost--resources should be employed in an activity so long as the economic returns generated are at least as high as any use of those same resources. An activity which generates economic profits, revenues minus all input and factor costs, meets this criterion of economic sustainability. An additional minimal condition can be added to his criterion with respect to activities which provide livelihood to households. In these circumstances, an activity must generate sufficient returns--either as direct output or cash receipts from sales--to provide subsistence to all family members. If this minimal condition is not met, families cannot survive from agricultural endeavors, and must rely on other means to survive. The most common strategy is either emigration, or immigration to urban centers. The result is the transfer of resources of unsustainable agriculture. These transfers engender serious problems, both for the families that move, and the urban areas where they settle, ranging from overcrowding, lack of sources and unemployment. Maintaining an economically viable agriculture is, thus, an important policy goal, not only as a way to improve conditions of the rural poor, but also as a means to reduce the rate of rural-urban migration.

This minimal subsistence interpretation of economic viability can be useful applied in farming systems research directed toward subsistence-oriented agricultural sectors. First, this approach explicitly identifies types of farms that fall below the subsistence level, and provides a quantitative estimate of the amount of the shortfall. Returns to agricultural activities depend of the access to inputs and resources (land, labor, capital) and the productivity of the available technologies with which these factors are transformed into outputs. Thus two directions for increasing agricultural returns to meet the minimum level of liability can be identified; increase available resources and increase productivity of available resources through technical change.

The first direction requires national-level intervention and involves large-scale shifts of resources among and between sectors. Such changes can only occur over an extended period of time and frequently face stiff political opposition. The second direction, increasing productivity, is the natural domain of FSR. The subsistence notion of sustainability provides a benchmark for identifying the need for increases in productivity necessary to attain subsistence levels.

For example, analysis may indicate that yields of a particular crop must increase by thirty percent in order for a certain type of farm to attain subsistence level. Technicians can evaluate the feasibility of such an improvement, and ways to pursue the goal.

Cape Verde provides an example of the subsistence criterion of sustainability. The agricultural resource base is extremely limited and productivity is low. Variation in rainfall patterns adds to the problems. The major staple crops are corn and beans. In good years, domestic production of corn equals 30 percent of consumption, and bean production is about 80 percent of consumption needs. Average corn yields are 800 kg per hectare, and bean yields are roughly 400 kg per hectare. Agricultural holdings are very small. The average amount of rainfed land per family is less than one hectare. Only a small percentage of agricultural families have access to irrigated land, and the average amount is less than on-tenth of a hectare.

A major policy objective of the government has been to increase the welfare of the rural population, in part as a way to stem the immigration to towns.

Data to assess the degree to which farm families meet subsistence requirements were collected in a number of ways over a period of four years of fieldwork. First, an island-wide survey was conducted to gather information about the distribution of access to agricultural resources as well as non-agricultural employment opportunities within the rural population.. A second panel survey was conducted on a sample of forty farm families over a one-year period. This survey was designed to obtain detailed, quantitative information about agricultural production technologies practiced and household consumption patterns. A third field exercise, based on informal, in-depth interviews with farmers in different parts of the island, provided technical information about production techniques. On the basis of these sources of information, the following analyses will be presented in the paper.

1. Representative farm systems. These systems incorporate information about rainfed and irrigated land area farmed, cropping patterns, livestock activities, labor requirements for agricultural activities, and family demographic characteristics.
2. Family subsistence consumption requirements. This information will be obtained from survey results, and from other studies based on nutritional requirements of individuals and nutritional composition of local foods.
3. Evaluation of the degree to which different representative farm types can meet their subsistence requirements. The evaluation will be made by comparing the cash value of all production with the cost of consumption needs.

On the basis of the above evaluation of representative systems, in conjunction with information about the relative shares of each system in the agricultural sector, estimates of the number and types of farms that fall below the subsistence level and the degree to which they fall short of meeting minimum requirements, can be made. With this information, more specific statements about the kinds of changes in productivity necessary to attain subsistence levels can be made. This data may also provide information about the types of research, extension , and investment programs that should be implemented to reach the non-sustainable farmers.

One example of such information about a specific area for further study is the issue of irrigation water allocation. Studies have shown that with more flexible access to water, farmers can switch production to higher profit and socially preferable food crops. Results from representative farm systems will be used to demonstrate this point. These results will also show the potential impact on household consumption patterns of such changes in irrigation practices.

In conclusion, the minimal definition of economic sustainability which imposes the household subsistence requirement has proved to be a fruitful analytical tool in farming system research works in Cape Verde.

15> SAME CONCEPT, DIFFERENT NAME?
SAME CIRCUMSTANCES, DIFFERENT PLACE?

Mark B. Lynham, Abou Oumar N'Gam

After the environmentally and financially disastrous years of the late 1920's and early 1930's in the United States, the U.S. Cooperative Extension Service developed into an agency that put the country on the road to world dominance in agriculture. Research, extension and education, a trio that greatly influenced the development of U.S. agriculture at both the farm level and the policy level. Fifty years later with similar conditions in many parts of the third world we are advocating the concept of "Sustainability" as an approach to agricultural development. Are we coming full circle? A different place but the same circumstances.

The FSR/E approach and methodology explicitly and implicitly covers all the concepts of sustainability. but in order to accommodate all the variants of FSR/E and also the various special interest the FSR/E concept lost much of its original vision of a holistic approach with a farm household orientation. The concept tended to emphasize certain aspects such as the immediate objectives of the farming family to the detriment and eventual exclusion of others such as the preservation or improvement of the environment. The holistic approach was (and is) being alluded to and not strictly followed. The concept of "Sustainability" tries to redress this imbalance between the explicit focus on the farm household and the implicit necessity to prudently manage the natural resources - short term economic welfare and the preservation of the environment - the present demands versus the future.

The available natural resources and the levels of industrial, economic, managerial and human resource development are the major factors that determine the rare of development (or deterioration) of the agricultural sector. All the factors are considered in both the FSR/E and the "Sustainable Agriculture" concepts. Unfortunately, because of the differing motivations, goals and objectives of the main actors and/or decision makers in the system these factors are not seriously considered together and thus sustainable agriculture development has not been achieved, specific examples being in Africa, but the reverse seems to be the case together with the alarming degradation of the environment.

16> A COMPARISON OF LABOR USE AND INCOME GENERATION FOR MAIZE-BASED CROPPING SYSTEMS IN THE MID AND HIGH-ALTITUDE ZONES OF THE WESTERN HIGHLANDS IN CAMEROON

Dermot McHugh

Twenty-four (24) farm families in 6 villages in the Ndop Plain (1150-1300 m. alt.) of the North West Province of Cameroon were monitored on a daily basis for 12 months in 1987, with a special emphasis on the maize-based cropping system. Data collected comprised daily labor use, by labor class and field operation; crop production as harvested: farm produce sales as transacted; and, weekly food-crop commodity prices in the village market. An identical study was carried out with 20 farm families in 5 villages in the Bui Highlands (1350-2300 m.) of the same province in 1988.

In both zones, maize is the staple food, eaten in the same manner ("fufu") with only slight variations in diet. Farmer nonland resources and goals are also comparable in the 2 zones. However, native soil fertility favors the mid-altitude zone. The high altitude zone is further hampered by its remoteness from external markets and having most of its arable land on slopes of between 10% and 40%, leading to severe erosion and a general yield decline over the last 20 years.

The principle differences in the maize-based cropping systems are directly or indirectly linked to altitude, including: maize varietal differences, cropping cycle, and crop associations. The cooler climate and longer growth cycle in the highland zone (6-7 months for maize compared with 4-5 months in the mid-altitude zone) combined with a greater frequency of double-cropping (second season beans and irish potatoes) produces a more even distribution of labor over the year, with less pronounced labor peaks than at the lower elevation. As a result there is less dependence on hired labor. In both zones, farmers have turned to dual purpose (food/cash) crops to supplement incomes traditionally earned from coffee (rice in Ndop and potatoes in Bui). Despite the differences, the net productivity in terms of farm family income for the 2 cropping systems is more or less equivalent.

The present paper compares the labor profiles and distributions among 6 classes of workers and 6 field operations for the two zones. The role of foodcrops in generating farm income is also discussed.

17> AGRICULTURAL INNOVATION AND TECHNOLOGY TESTING BY GAMBIAN FARMERS: HOPE FOR INSTITUTIONALIZING OFR IN SMALL COUNTRY RESEARCH SYSTEMS?

Bradford Mills, Elon Gilbert

The paper summarizes the results of a survey of recent technical innovations, adaptations, and adoptions in two extension districts in Eastern Gambia. The factors influencing farmer innovation are reviewed. Finally, the paper examines the feasibility of giving farmer groups and development agencies primary responsibility for on-farm farmer-managed researched activities in countries, such as The Gambia, where resource and manpower constraints may seriously limit the geographic and subject/commodity coverage under conventional models of FSR/E which depend primarily upon the research services.

The Gambia is a small country in West Africa which is surrounded on three sides by Senegal. Historically it has been a vital link in West African trading routes due to its location and the navigable river which runs the length of the country. Today, Gambian farmers retain the historical advantages of their location through their access to agricultural technologies developed in many other areas of the West Africa sub region. Farmers also play an active role in the testing and modification of these agricultural technologies. Such initiatives by farmers are a vital factor in Gambian agriculture but have been given inadequate attention in development efforts.

Gambian farmers have made a number of specific changes in their farming systems in response to the decreased rainfall and the growing land scarcity of the last two decades. A number of farmers have tested and adopted early maturing varieties of groundnuts, millet, sorghum, maize, and rice. The new varieties have come from a number of sources, most frequently through other farmers and weekly markets. In both districts farmers have also experimented with various labor enhancing technologies to alleviate critical labor constraints at first weeding. These include fully mechanized cross row cultivation techniques; enhanced productivity of implements through modification by local blacksmiths;l and the use of herbicides bought in neighboring Senegal.

Overall, the results indicate that a large portion of technical change is occurring due to farmer initiative and with minimal involvement by formal development projects and agencies. Based on these results, factors affecting technical change in The Gambia are discussed, including resource availability; linkages to sources of innovation; accessibility of inputs; government policies; and socio-cultural factors on both the intra and inter household level. Key leverage points for facilitating technical change are briefly explored for each factor.

The paper discusses possible roles for the research services which compliment the spontaneous efforts of farmers in the development and testing of agricultural technologies. Small

developing countries, such as The Gambia, face very binding resource constraints, particularly skilled manpower, which require difficult choices in the selection of research strategies as well as commodities and subjects. For most subjects/commodities, the role of the Gambian research services may be limited to linking development agencies and the farmers they serve with sources of innovations and not carrying out any research per se in country. Even for high priority topics, there must be greater reliance on what development agencies and farmers are able and willing to do for themselves in the testing and development of agricultural technologies.

Finally, the paper proposes a scenario through which the assorted development agencies, within the country, could link with the research services to foster the process of innovation and adaptation among Gambian farmers. Many development agencies, notably the NGOs, have already developed farmer groups. These groups can take an active role in technology testing as well as the design of modifications which might increase the productivity of specific technologies. Farmer participation in agricultural research could thus be assured even though the resource constraints of the research service may limit the application of more conventional models of FSR/E.

THE IMPACT OF FARMING SYSTEMS RESEARCH IN MOZAMBIQUE: THE SUSTAINABILITY OF IMPROVED TECHNOLOGIES IN THE GREEN BELTS OF MAPUTO <18

Firmino Gabriel Mucavele

Small farmers in Mozambique play an important role in agricultural development. While more than 90 percent of the cultivated area belongs to the small farmers, these farmers do not yet apply the agricultural technologies generated by the Research Stations.

In 1984 some Farming Systems Research Programs were launched in the Country to generate technologies for the small farmers. Some of these programs, within the Green Belts, were intended to increase food production to supply Maputo, the capital city of Mozambique. This paper presents the impact of the Farming Systems Research in the Green Belts of Maputo, focusing on the sustainability of the improved technologies generated through on-farm research.

The Farming Systems Research approach was used to identify the major constraints of the system and to generate data for analysis. Correlations and Comparative analysis were done.

The study concluded that the small farmers use different patterns of efficiency from those used by the researchers in on-station research. There is, already, evidence of farmers adopting some improved technologies generated in on-farm research in the Green Belts of Maputo. These technologies prove to be acceptable and sustainable under the farming systems and conditions of the farmers of Maputo.

FSR/E AND ITS INSTITUTIONALIZATION IN GREAT LAKES OF BURUNDI, RWANDA AND ZAIRE <19

Kasonga Mukandila, Augustin Bizimungu

English translation unavailable

SUSTAINABILITY OF AGRICULTURE IN MAURITANIA: UNDERSTANDING AGRICULTURALISTS' RATIONALE <20

Abou Oumar N'Gam, Mark B. Lynham

There has been much discussion of sustainability or of reproducibility of agriculture. In the context of agronomic research, sustainability implies an appreciation of the importance of environment and economics in the development and transfer of technology. In other words, technologies to be implemented need to be perfectly matched with real problems associated with agricultural production.

Situated within Africa's Sahelian zone, Mauritania has been hard hit by the drought of the past fifteen years. With a fragile environment and extreme sensitivity to climatic or human action, its ecosystem has been affected with unprecedented force: the advance of the desert has accelerated, its natural resources have diminished, and its arable land has decreased.

Given this situation, the government and its development agencies have steered their agricultural policies toward irrigation. In their eyes this approach appears as a miraculous solution for resolving a difficult equation – how to produce enough to feed a rapidly growing population at a time when available arable land is diminishing considerably. In spite of large investments, the results of the existing production system have been judged as poor.

As for the agriculturalists themselves (cultivators and livestock raisers), their reaction in the face of this calamity has been to emigrate toward urban centers. Only a small number of these agriculturalists have worked in irrigated agriculture.

After a few years of practicing riziculture, these farmers quickly became disillusioned upon returning to traditional agricultural systems wherever environmental conditions improve sufficiently to permit such a return.

In effect, extensive agriculture offers many more advantages than intensive agriculture: higher yield per hour of labor, lower risk, no need for imported inputs, less dependence on formal training institutions.

Furthermore, reconnaissance surveys and research have shown that the solution to the nutrition problem and to the stabilization of rural population tends to be the harmonious use of indigenous systems of agriculture rather than placing emphasis on irrigation. The reasons for this observation include: lack of technical training of agriculturalists, insufficient opportunities for obtaining such training, difficulty of obtaining inputs locally, and lack of infrastructure.

Funding agencies, long captivated by the logic of irrigated agriculture, have only recently begun to appreciate the real problems of agricultural development in this country. The rational production figures demonstrate clearly the need to develop all four principal systems of production: rainfed, recession, irrigated, and "derriere-barrage".

Through the farming systems research method employed in the above mentioned studies, the AGRES II project has been able to identify the major constraints to production felt by cultivators. In effect, the ultimate aim of this project is to contribute to the improvement of the quality of life of the region's rural residents. This can be achieved by increasing agricultural production while mitigating environmental deterioration.

In conclusion, to achieve sustainable development, research should pay attention to the needs of agriculturalists. This is the most important lesson to be drawn from the Mauritanian example.

THE IMPACT OF FARMING SYSTEMS RESEARCH ON AGRICULTURAL PRODUCTIVITY: A CASE OF NORTH CAMEROON <21

D. S. Ngambeki, R. R. Deuson, and J. Lowenberg-DeBoer

Between 1986 and 1989 a farming systems research project was carried out in North Cameroon. The project used a whole-farm approach whereby a group of scientists working as a team attempted to improve productivity of the existing farming systems in the target area by pursuing the following objectives:

1. to develop agricultural production technologies adapted to conditions and needs of small scale farmers in the semi-arid zone of North Cameroon.
2. to foster the transfer of agricultural technologies by conducting on-farm adaptive research in partnership with farmers, extension agents and station researchers.

The FSR team and their collaborators, recognizing the interrelationships between soils, crop production, agroforestry and livestock subsystems, identified the major production constraints,

and designed and tested new cropping systems capable of sustaining productivity and profitability.

This paper shows the potential impact of a joint venture between an FSR team, extension agents and farmers. Two-way linkages were created, accelerating the transfer of agricultural technologies obtained at research stations to farmers as well as providing a feedback to station-researchers and extension/development agents. The authors demonstrate in this paper how the integrated output of a Farming Systems Research program, based on soil fertility management and/or crop variety technologies, can raise the productivity of particular cropping systems and improve the profitability of the farm as a whole in a sustainable way.

22> FARMERS' PARTICIPATION IN OFR: THE INITIAL CONTACT

Laurent Nounamo, Augustin Foaguegue

How smallholders can be brought to participate in OFR activities is yet to be developed and may differ according to cultural, social and agro-economic back-ground. The initial contact between researchers and smallholders can be determinant in facilitating or complicating smallholders participation in OFR activities. The IRA-IITA-IDRC FSR project in the forest zone of Cameroon near the city Yaounde has gained experience in the aspect.

To ensure the smooth running of the project, the IRA-IITA-IDRC FSR team followed three contact phases of social interaction between researchers, smallholders, extension service and local government: (1) exploratory phase contact, (2) official contact, (3) O.F.R. establishment contact. To facilitate researcchers' contacts and interactions and data collection in the villages, three types of cooperators were selected: (1) village chief, (2) village level field assistants, (3) farmer cooperators. The social roles of farmers and researchers, as view by one another, was identified. To solve he problem of the "rules of first contacts", that is, farmers taking researchers for government officials, time was taken to explain repeatedly the specific objectives of OFR and its potentials, instead of trying to show what the project "is not". To solve the problem of "guests status", that is, researchers treated as guests with special rights and privileges, which do not necessarily express goodwill towards the project objectives, feeling of success was reduced at this stage by researchers. The end of the "guests status" is marked by the requests and demands of villagers for employment and payment for cooperation, and by symptoms of tensions and conflicts. To solve these problems, different attempts were made. What finally worked was to discuss openly in the village meetings the method of payment for task work. The payment was only make to village field level assistants for data collection, field measurements and collection of information from other farmers. Farmers were not paid for work on their own fields or for any technology failure. Risk of failure was reduced: Only promising technologies were tested on farmers' field and was in a proportion such that its failure will not affect farmers' harvest much. To obtain farmers participation of O.F.R. work it is special importance that the farmer sees himself as the owner of the trail and considers the crop as his property.

23> EXTENSION STRATEGIES FOR SUSTAINING FARMERS PARTICIPATION IN AGRICULTURAL DEVELOPMENT: A CASE STUDY OF THE KANURI FARMERS IN BORNO STATE OF NIGERIA

Titus Ogunfiditimi

The Kanuri farmers are found mostly within the Arid Zone Agriculture of the Borno State of Nigeria. They are predominantly small scale farmers and live in the rural areas of the State. They are in the designated Agricultural Extension Zone (AEZ) of Borno State and are exposed to the Work Bank/Federal and State Governments assisted agricultural projects. Some of these projects include institutional development projects such as rural feeder road, rural banking, marketing and irrigation. Others are production oriented projects such as input supply of high yielding varieties of crops, pesticides, land preparation and storage.

In recent years, the issue of sustaining benefit flows of World Bank/Federal and State Governments supported development activities following a "Phase-Out" of development assistance to the rural farmers in Nigeria has been a major concern for all and sundry.

In view of this, the study was directed and designed to find out the ways and means by which the farmers can continue to participate actively in Agricultural development processes of their areas after any "external assistance" to them has been phased out.

Two (2) local government areas of Borno State were selected for the study. They are Biu Local government area and Konduga Local government areas respectively. One hundred (100) farmers each from the two local government areas were randomly selected. A total of two hundred (200) farmers were selected and interviewed.

A structured questionnaire with twenty (20) items built around what Extension per se can do to sustain farmers participation in agricultural development was designed, pre-tested and administered.

Data were subjected to frequency counts and Multiple Regression Analysis. The computer sub-programmes on these techniques from Statistical Package for Social Science (SPSS) were used. Alpha (a) was set at 0.05 level of significance and thirteen (13) extension related functions aimed at sustaining farmers participation in agricultural development were identified.

These functions are:

1. Formation of farmers into production cooperatives.
2. Ensuring effective, adequate training and skill development in farm management.
3. Involving farmers in all facets of farming decisions.
4. Concretizing sustainable output promoted activities.
5. Formation and utilization of infrastructural farmers maintenance groups.
6. The development and implementation of Agribusinesses.
7. Teaching and inculcating in the farmers the opportunities and potentials inherent in agriculture as a career.
8. The development or systems approaches that favor backward and forward institutional linkages in agriculture.
9. Familiarization with and the use of sustainable teaching devices.
10. Adoption and use of intermediate technology.
11. Encouraging the formation and promotion of farmers social groups and local organizations.
12. The development of effective mobilization procedures.
13. Formation and utilization of farmer's research unit and trouble shooters team.

24> INTRODUCING ANIMAL-POWERED FORAGE PRESERVATION INTO TROPICAL FARMING SYSTEMS WITH LONG DRY SEASONS

Richard J. Roosenberg

Introducing ensilage and hay-making in Sahelian Africa could substantially increase cattle health and production and reduce deforestation and decertification caused by dry-season over-grazing. Such a change would have a revolutionary impact on present farming systems. This paper explores an apparently practical method for introducing forage preservation and analyzes its fit in and affects on present farming systems.

In labor-intensive farming systems, the availability of labor through the seasons interacts with the demands of crops mixed in a rotation and the needs for animal care to define the basic management options of each farmer. Solutions to major problems in farming systems that do not require large infusions of cash usually disrupt the equilibrium that may have developed within those systems.

The Tillers program of Rural Futures International has been

working on systems of forage preservation that would be low enough in cost so small farms could afford them and efficient enough so they would be profitable within existing labor opportunity costs. The systems are based on scythes, hand rakes, ox-drawn cart of wagons, stationary choppers powered by small engines, and trench silos excavated by ox-drawn slip scrapers.

To test the potential for such innovations, we have superimposed them on the present farming system of Kerou, Benin about which we have substantial descriptive data on cropping systems and labor distributions. The labor distribution analysis shows that most of the labor required by the added forage tasks would fit in "windows" of seasonal slack in the existing system. This window is about a 10 week period after peak demands for tillage and weeding end in late July and before the harvest of cotton, peanuts, and sorghum begins in mid October. With modest sharing of labor, there would be enough time in this period for a small farm to make adequate ensilage and hay (about 40 tons) to feed a herd of 20-30 cattle for the 4 driest months.

From a socio-economic perspective on the farming system, forage preservation would provide the needed relief from pressures caused by the recent growth of rural populations and herd sizes. Although there is significant interest among nomadic herders in maintaining their traditional herding practices, there is also a growing realization that current pressures are going to force changes. Intensifying forage production may be one of the least painful changes. Additionally, it offers the potential of increased profits from reduced dry-season weight losses. The sedentary farmers have already shifted from a traditional shunning of large animal husbandry to maintenance of oxen for draft power and young stock for draft replacements and beef sales.

From an ecological perspective, the farming system's division of labor between sedentary and nomadic groups which served well when there was enough land to successfully support shifting cultivation and extensive pasturing, is yielding to a mixed farming system. Mixed farming is much more likely to sustain today's greater population densities. To claim the benefits of manuring and crop rotation that are possible with mixed farming, a practical system of forage preservation is necessary. Land pressures no longer allow enough fallow time in rotations for fertility to be rebuilt by a return to "bush". Moving toward cultivated forage crops within rotations will allow useful fallows which can more quickly restore soil fertility and keep fields cleared of plow stopping stumps until their return to cultivation.

Thus, the introduction of forage preservation seems to fit the changing circumstances of the Sahel very well if the cost of the mechanical systems are kept down. It appears to fit the agronomic rotation, the livestock need, the social changes, and the present distribution of labor requirements. In short, the integration of forage preservation into the Sahelian farming systems should result in their becoming substantially more profitable and sustainable.

A SUSTAINABLE INSTITUTION AND ACCEPTABLE TECHNOLOGIES: STEPS TOWARD A METHOD FOR ON-FARM RESEARCH <25

Abdelilah Sefrioui, Richard Riddle, Ahmed Herzenni

The Aridoculture Project in Settat, Morocco, was initiated with two primary goals: 1) the establishment of a functioning, sustainable research institution that would address dryland agricultural issues at the regional level, and 2) identify and develop technologies that would both improve the productivity and the profitability of existing farming systems. The Project is an integral component of a national goal of achieving greater agricultural self-reliance.

The establishment of a viable research institution has included the training of scientists in a variety of agricultural disciplines. The scientific methods promote the conduct of research under controlled conditions. To attain the requisite levels of control, the agricultural scientist is oriented toward conducting research on the agricultural experiment station. During the start-up phase, most agronomic trials were in fact conducted on-station, where controlled conditions were present.

The objective of on-station trials is to discover improved technologies, i.e. technologies which consistently produce yields superior to those observed with traditional ones, in a statistically significant way. Hence the on-station attempts to minimize the variance of yield.

Off-station research entails increases in uncontrolled variability. The objective of the researcher is to understand the components of variance, i.e. to understand the sources of heterogeneity in the farmers' environment. But there was considerable hesitancy on the part of researchers who were just beginning their scientific careers to venture into an environment that was rife with uncontrollable variation. But the goal of identifying technologies that are viable in that environment and acceptable to producers demanded the identification of methodologies that permitted variation to be included in the research process.

Off-station research had two different points of departure. Production scientists initiated a program of researcher managed on-farm diagnostic and verification trials. Our social scientists had been primarily occupied with describing producer strategies and practices. They also expressed concern as to whether or not research addressed problems that were accorded priority by producers, and were developing technologies that would be acceptable alternatives to those with which farmers were familiar. But merely to express concern is not always convincing to production scientists. They needed a method to present that concern so that hypotheses could be generated and scientifically tested. There was a need for feed-back from the work off-station that was presented in terms that were understandable to production scientists.

Project social scientists considered it imperative that the producer be involved in the research process. A series of "on-farm producer evaluation trials" were initiated, wherein a sample of producers were given a small quantity of seed of a new wheat variety and simple instructions. The "trials" would thus be conducted under producer conditions. Agronomic measures were made by a member of the team, and producers were interviewed as to their evaluation of the variety. The results of this method were not convincing to the production scientists, who pointed to the lack of control treatments.

For the social scientists the methodological problem became one of how to conduct producer managed on-farm trials that provided for a level of control that assured a level of scientific credibility. A methodology for farmer-managed trials which incorporated treatment levels while emphasizing simplicity (a 2 x 2 factorial) was identified through consultation and farming systems literature. The trials were monitored by the team agronomist. Yield measurements were taken at harvest, and producers' evaluations recorded.

The agronomic results were immediately understandable to production scientists. They appreciated the evaluation of on-station tested technologies across a broader range of conditions or production environments. This method is a heuristic one for the sociologists and economists, in that it directs their research toward identifying socio-economic variables that may explain, for example, variations in yield.

A sustainable research institution requires more than infrastructural support. It must demonstrate that it is addressing its research to priority issues in the agro-climatic and socio-economic environment of its farmer clients and finding acceptable alternatives. Farmer managed on-farm trials, continued interdisciplinary research that seeks to explain variation in yields and returns off-station, and the identification of recommendation domains, are essential steps in the elaboration of technologies that will be accepted by producers.

26> ANALYSIS/DIAGNOSIS OF CAMEROON WESTERN HIGHLAND CROPPING SYSTEMS: THE CASE OF BAFOU

Fidele Tetio-Kagho, Guy Ducret, Pascal Bergeret

The Bamileke high plateau of Western Cameroon is a densely populated, tropical, mid-altitude region with intensive agricultural activity. The village of Bafou, with a population average of 500 people/km^2, is representative of this region in that it contains the four principle ecological zones (high altitude, volcanic piedmont, basaltic, and granitic). The high population density is made possible by a combination of favorable natural environment, social organization, and intensive and specific cultural practices. Population pressure and increasing integration into a national economy are forcing the Bafou cropping systems to become increasingly intensified and diverse. Based on two levels of observations (individual farms and the landscape in general) eight major cropping systems can be distinguished (most to least frequent): Arabica coffee associated with food crops, yearly food production at the base of hills, temporary food production at the summits of hills, lowland vegetable production, dry season vegetable and food production bordering raphia palms, raphia palm production on flooded land, and silvaculture. Each of these cropping systems, with its specific agronomic features, is integrated into the whole farming system. A broad analysis/diagnosis shows that the consequences of increasing intensification in terms of viability of the system differ from one system to another. The major constraint for the first five cropping systems is soil fertility (management of organic matter, supply and use of mineral fertilizer, and erosion control). Some systems present specific problems such as post-harvest handling and loss, and pest control (chemical supply, use, cost, and hazards). Cropping systems on the young soils of the high altitude regions show potential for further intensification, but those on the less favorable areas (hill tops in the granitic zone for example) appear to have reached a disequilibrium point if no immediate intervention is forthcoming.

27> IS FARMER INPUT INTO FSR/E SUSTAINABLE? THE ATIP EXPERIENCE IN BOTSWANA

Chada Tibone, Frederick D. Worman, Geoffrey M. Heinrich

This paper discusses one approach to obtaining farmer input to agricultural research. A comparison between farmer involvement in on-farm research with a farming systems perspective and the traditional farmer involvement in agricultural research in Botswana is made. Traditionally, on-station research has had little farmer participation. On-farm projects in Botswana worked on farmer's fields, but researchers set the agenda. Topics were chosen by researchers and/or extension agents. As a result farmers lacked effective input and inevitably lost interest in participation. For example, on-station research field days are for researchers and administrators; and on-farm projects had which were researcher managed and usually researcher implemented.

The early ATIP approach was much like other projects, with a researcher determined agenda. Later, researcher led farmer testing groups were introduced to increase researcher efficiency and facilitate farmer testing and evaluation of options they chose. To promote efficiency for village level extension staff and to facilitate farmer assessment of extension recommended technologies, extension led farmer testing groups were established. Through these farmer testing groups, on-farm research has provided improved linkages between farmers, extension staff and agricultural researchers, both on-station and on-farm.

Farmer testing groups seem to encourage and sustain farmer participation in the technology development process in that they serve farmers interest as well as researcher interests. The approach has four major advantages. First, the structure ensures that farmers are working on topics in which they are interested and which can be accommodated within their resource structure. Second, groups serve as a source of new information since farmers share their experiences with new technologies and researchers present new technologies for farmer consideration. Third, the group format is very flexible and can change with changing farmer interests and circumstances or respond quickly to by addressing new problems. Finally, groups are fairly simple to operate and can be handled by experienced technical officers with assistance and advice from on-station research specialists.

The effectiveness of the ATIP approach is examined. The approach seems to have been effective in getting farmer participation and involving researchers, farmers and extension officers at the local level. Group participation has remained strong and the number of trials has continued to grow from 12 trials on one type in 1985-86 to over 150 trials of more than a dozen technologies in 1987-88. Spontaneous adoption will be reported. Collaboration between on-station and on-farm researchers has increased and many technologies have been tested. The number of extension led groups has also increased as has interest in the approach.

Factors influencing the continuation of this type of farmer involvement in agricultural research in settings similar to Botswana will be discussed.

28> COMBINING MACRO-AGRICULTURAL POLICIES AND FARMING SYSTEM RESEARCH TO ACHIEVE SUSTAINABILITY AND FOOD REQUIREMENTS: THE NIGERIAN CASE STUDY

S. Tunji Titilola, Suresh Babu

Sustainability, which implies changing agricultural production systems so that farmers are able to keep producing indefinitely, is a relatively new concept in agricultural production. Until a few years ago, farm productivity, regardless of the impact on the ecosystem, was the major concern of developed countries (DC) and less developed countries (LDC). The importance of sustainability of agricultural production systems is rapidly becoming a major concern of agricultural research and policy makers both in DC and LDC. The importance or need for sustainability in production systems is, in part, due to:

- high cost of nonrenewable resources,
- depletion of renewable resources as a result of environmental degradation traceable to agriculture, and,
- the continued ability of the present production system to continue to provide food for increasing world population.

Two crucial issues therefore become pertinent to the concept of sustainability in any farming system. These are: resource renewability and production costs.

The purpose of this study is to find out the farming system(s), that will achieve sustainability and self-sufficiency (i.e., minimum daily requirement of calories and protein) in selected food items in Nigeria. Given the projected demand and supply of food in Nigerian economy over the years and macro-food policies, a household production model is developed to identify beneficial farming systems. The methodology employed is linear programming in which production and nutritional constraints are resolved. The model is also used to study the allocation of land between commercial and subsistence crops given various policy alternatives. Potential policy results include the type(s) of farming systems that will be needed to achieve the objective sustainability and food self sufficiency and national policies that will be required to channel resources to the achievement of objectives.

REGIONAL SESSION: ASIA

RURAL HOUSEHOLDS AS PARTNERS IN ADAPTIVE RESEARCH: THE CASE OF PARTICIPATORY GENERATION AND VERIFICATION OF IPM TECHNOLOGY IN THE PHILIPPINES <29

Candida Adalla

Integrated Pest Management is a people-oriented technology whose successful implementation largely depend on a number of interrelated technical, social and economic factors. Experiences in the national ipm research cum demonstration project using the participatory approach indicate that the economic and social pressures of the cooperating farm households to produce a good crop affects the ultimate and total adoption of the technology.

The participatory method of conducting on-farm adaptive research and extension trials show the advantage of a two-way direct learning process between the researchers and the cooperating farmer and his household.

Case studies on success and failure studies were documented and problems attendant to the participatory method of conducting adaptive on-farm research are discussed in the text. Constraints in farm or village adoption of integrated pest management in rice from technical point of view will also highlighted in the discussion.

COMPARISON OF DIFFERENT CROPPING PATTERNS ON RAINFED LOWLAND AREAS OF THE PHILIPPINES <30

Nizam U. Ahmed, P. E. Hildebrand, V. R. Carangal

In the Philippines during the post-rainy season in rainfed lowland rice (*Oryza sativa* L.)- based environment, farmers occasionally grow mungbean [*Vigna radiata* (L.) Wilczek] and/or cowpea [*Vigna unguiculata* (L.) Walp. subsp. *Unguiculata*], otherwise the land remains fallow. To increase the biological and economic productivity of the system, five different cropping patterns involving three different dual purpose extra early legumes – mungbean, cowpea, and pigeonpea [*Cajanus cajan* (L.) Millsp.], either as sole or in intercrop combination in a zero tillage, residual soil moisture condition following lowland rainfed rice were compared with farmers' cropping patterns for two years across five locations in farmers' fields and one location at the International Rice Research Institute (IRRI), Philippines. The farmers' patterns were managed by the farmers with the farmers' own practices and the tested patterns were managed by researchers with recommended practices.

In rice production during the first year, recommended practices gave higher or equal grain yield than farmers' practices but not higher return to investment owing to high labor cost for transplanting in rows and use of wider row and plant spacings resulting in higher weed control cost. In the second year, plant spacings were reduced which increased the grain yield and improved the economic profitability of the recommended practice over farmers' practices but still net return per dollar transplanting and weeding costs were higher in the farmers' practices. Farmers were not interested in row planting because of the high labor requirement which was very scarce at peak planting time.

Performance of legumes, either alone or in intercrop combinations under zero tillage, residual soil moisture condition following lowland rice, was not good in most of the locations tested during the first year because of fertilizer application which favored weed growth and initiated regrowth of the rice stubble. Use of a hand tractor with drag stick for opening furrows and hand seeding was also economically unproductive because of the high labor requirement. Use of an inverted T-seeder in the second year was effective in seedling establishment, time saving and economic productivity. NO use of fertilizer and better planting equipment improved the overall performance of the legumes across the locations during the 1987 dry season. Statistical analysis using gross return values as a substitute for grain yield of different legumes as a sole or in intercrop combination indicated highly significant interaction between location and treatment. Modified stability analysis using gross and net return values indicated at least two recommendation domains. Production of legumes either alone or in an intercrop combination was profitable only in the productive environments during the 1987 dry season. Distribution of confidence intervals using net return data of the three best performing treatments over all five test locations indicated negative return at least in one out of four years. but in the more productive environments (two good locations), the risk factor disappeared dramatically indicating a good profit with at least 95% confidence.

Intercropping of pigeonpea with cowpea was the best both in terms of modified stability analysis and confidence intervals in the better environments. In the poor environments, grain yield was not enough to economically justify the production of any legumes. However, fodder yield of pigeonpea in moderately poor environments indicated promise for the future when fodder will have economic value.

The farmers' practice of growing mungbean by plowing the field followed by broadcasting the seeds and subsequent harrowing gave better crop growth, higher grain yield and economic productivity compared to zero tillage planting of mungbean under moisture stress situation. But mungbean or cowpea planted with zero tillage with little or no moisture stress at IRRI exhibited excellent performance.

At two out of five locations, all the tested patterns performed better than the farmers' pattern but productivity of the tested patterns varied. At one location, one but the other tested patterns performed better than the farmers' pattern. In the rest two locations, farmers' cropping pattern rice-fallow was the best.

VAried performance of the low resource base technologies tested across the locations signified the role of FSR/E activities in the development of sustainable agriculture in small farm environment.

EXPERT SYSTEMS BASED ON INDIGENOUS KNOWLEDGE FOR VARIETAL SELECTION IN FARMING SYSTEMS RESEARCH <31

Suresh Chandra Babu, D. Michael Warren, B. Rajasekaran

Recently utilizing indigenous agricultural knowledge of the farmers in developing appropriate technologies has been increasingly recognized as a method of attaining sustainability in agriculture in rural development programs. This paper discusses the development and use of "IKSEXPERT" (Indigenous Knowledge Systems Expert), a used interactive expert system for varietal selection within the framework of farming systems research. Indigenous knowledge systems in agriculture forms the basis for the construction of the knowledge base in the expert system program along with the farming systems research trials involving parameters from agronomic field evaluations on varietal responses to fertilizers, insect and disease pest management and irrigation.

The IKSEXPERT provides recommendations on crop varietal selection on various crops, given soil type, rainfall availability cropping pattern, resource constraints and prices of outputs. Characteristics such as cooking quality of the produce, susceptibility of the variety to the insect pests and diseases and the nature of drought resistance are also taken into account in developing the program. The program enables the extension and village level workers to identify, document and utilize the indigenous knowledge of the farmers in decision making on crop varietal selection.

A case study incorporating indigenous knowledge of rice varieties by farmers of south India is presented to demonstrate the use of IKSEXPERT. The major advantages of the program include easy use with personal computers and lotus data management systems without requiring any additional programming skills. Similar programs with minor modifications in IKSEXPERT could be developed for irrigation management, soil classification, nutritional recommendations and plant protection practices at the farm level to increase the appropriateness of farming systems research to the farming community.

32> SUSTAINING THE FSRE CONCEPT IN A NATIONAL AGRICULTURAL RESEARCH CENTER IN JORDAN: FOCUS ON A TRAIN-THE-TRAINER MODEL

Robert O. Butler, Lorna Michael Butler

INTRODUCTION

Agricultural research centers generally have a poor track record with clientele who are in greatest need. One of the principle problems has been in getting the message out to limited resource producers and members of their households. Effective research systems must generate technical recommendations that are practical and profitable. At the same time, there must be some sort of linkage whereby there is mutual understanding, communication and support between researchers and end-users (farmers). In LDC, mutual understanding is critical in order for research to generate low-cost, practical solutions to problems. This may be the kind of research that innovative or "research minded" farmers generate themselves, or that which is done in collaboration with researchers, and/or Extension personnel.

Another problem has been with the appropriateness of the research message. Farmers have simply not found national research program recommendations suitable to their own situations and needs. This frequently occurs because of the wide gap that exists between the generators and users of technology.

The purpose of this paper is to describe and analyze the research-technology transfer system adopted by the Hashemite Kingdom of Jordan at the National Center for Agricultural Research and Technology Transfer (NCARTT). A commitment has been made by the Ministry of Agriculture to institutionalize an integrated training-research unit in the center. The primary responsibilities of the unit are to provide leadership for (1) transferring research findings to users, and (2) training the center staff to do this. Since the NCARTT model is based on the FSRE concept, the principal function of the unit is to sustain the FSRE concept throughout the institution.

THE TRAINING-RESEARCH MODEL

This paper will trace the development of a training-research unit as one way of integrating technical subject matter sections of NCARTT in dissemination research findings and recommendations to field personnel. It will elaborate on the train-the-trainer model implemented in 1988. This approach brings together individuals from different academic backgrounds that represent agriculture research sections and Technology Transfer (Extension) field staff.

LESSONS LEARNED AND IMPLICATIONS

The presentation will expand on experiences and lessons learned from the initial two years of NCARTT's establishment, including the planning and development of a train-the-trainer workshop model.

The Jordanian model balanced theoretical and practical training. It brought together practical skills and knowledge of program example, trainers and participants developed practical skills in clientele involvement in assessing plant protection needs. Needs assessment skill development and plant protection knowledge were integral parts of the training curriculum. In the process, 450 farmers were interviewed using a sensing interview technique, then the data was analyzed by the participating trainees. Data was also collected from Extension staff about their own organization using the same techniques.

Implementation of the train-the-trainer model resulted in products that were important to all workshop participants, for example, organizational and programmatic change; in-service training in technical subject matter identified as important to participants; logistical support; a program planning data base.

Implications and conclusions are based on the outcomes of the ten-week workshop, and approximately twelve months follow-up. Issues to be addressed include: technical discipline involvement and commitment; resource allocation; cultural compatibility; trainer identification, personnel selection and support; Extension integration; organizational structure and policy.

33> TOWARDS SUSTAINABLE AGRICULTURE: INTEGRATING WOMEN INTO FSR

Shanti Chakraborty, J. E. Gleason, B. Mandal, C. S. Das

Sustainable agriculture development is best achieved through full development of human resources in rural areas. Recognizing the need to work with all household members in agricultural development projects, the Ford Foundation-funded Farming Systems Project of the Ramakrishna Mission in Narendrapur, West Bengal, has initiated a homestead garden program aimed at integrating women into the overall project. This paper reports on the methodology used in the garden program and the results.

In coastal West Bengal, as in most parts of Asia, women's contribution to homestead vegetable production is recognized as an extended domestic activity. Even if men help with this activity, the role is attributed to women. Given this perception, FSR scientists at RKM implemented a garden program for village women. The program has two fundamental objectives: (1) to increase the production of vegetables year-round in order to improve family nutrition and increase incomes, and (2) to provide an entry point for women to be included into the overall project by breaking down the barriers which inhibit them from acquiring technical information.

Each season RKM scientists hold garden program meetings with village women. In an informal and relaxed setting, women sit with the scientists to discuss their concerns about homestead vegetable production. The matters discussed include types of vegetables to be grown, quality of seeds, water problems, preparation of compost, etc. Based on these meetings, scientists recommend a sequence of vegetable plantings so that they have a continuous supply throughout the year. The goal of the program is to systematize vegetable production so that at least one kilogram of vegetables can be harvested every day.

Over two hundred women have participated in this program in the last two years. The results of the program are impressive in terms of production. The cooperating women have increased homestead production of vegetables, and the interaction with scientists has also increased their contribution to commercial vegetable production. The cultivation methods promoted for the homestead garden are being applied in a larger context. In addition to increased incomes and consumption of vegetables, this program has led to more full employment of labor in the villages.

The garden program has also led to greater interaction between women and scientists, and has dispelled some of the notions which generally interfere with women's access to scientific information, extension services, and other essential inputs. RKM scientists better understand the role of women in agriculture and are now more apt to include them in other project meetings.

Breaking down the barriers which prevent women from joining development efforts is a slow process. But it is necessary to include women if sustainable development is to occur. This paper discusses in detail the process which RKM uses to ensure that women's contribution is known and included.

34> THE DEVELOPMENT OF FARMING SYSTEMS RESEARCH IN NEPAL: THE WORKING GROUP AS A FOCUS OF INTERDISCIPLINARY ACTIVITY

David Gibbon, Hem Thapa, Peter Rood

Farming systems research has had a relatively short history in Nepal. It has developed against a background of strong commodity

and disciplinary divisions within and between relevant Ministries. FSR was based on crop and cropping systems research and there was strong influence from external agencies in the evolution of appropriate structures and methods.

This paper examines the development of farming systems research approaches within the context of Pakhribas Agriculture Center which has a strong disciplinary-based structure. In order to create a working environment in which scientists, extensionists and farmers can interact effectively, a series of interdisciplinary working groups have been set up. While this device is not new, it has enabled the Center to overcome some important problems - of overlap and of inadequate coverage of topics that did not fall into an obvious category - and to involve a wider range of participants than had been the case previously.

The paper examines each of the Groups in turn, shows how they are approaching their particular problem area and how they relate to other activities. The Groups are expected to be of particular value to the Center outreach program and in the fostering of a greater understanding between scientists, extensionists, and farmers.

PRODUCTION AND PROFITABILITY OF NEW FSR TECHNOLOGY: A CASE STUDY IN ILOILO, PHILIPPINES <35

Raymundo R. Gonzaga, Nimal Ranaweera

The shift from the traditional monocrop-oriented approach in agricultural development to a more holistic approach e.g. Farming Systems Research, has played a major role in agricultural development programs. Almost two decades later, questions are being raised as to the effectiveness and contributions of the approach to its target clientele. An assessment of its impact to the farm-household economy was conducted in the rainfed areas of Oton-Tigbauan, Iloilo, Philippines. This is the site where a rice-based rainfed technology was developed under the Cropping Systems Research framework.

Two data sets were used in the study: the cropyears 1975-1980 Farm Record Keeping (FRK) activity on 48 farmers and the information collected from 50 farmers monitored during cropyear 1987-88.

A comparative study between pre-technology and post technology adoption period indicated positive changes or most production parameters. Specifically, the introduced technology resulted in higher land productivity due to increased cropping intensity; reduction in labor cost as a result of the shift in the method of crop establishment i.e. transplanting to direct seeding (and partly due to mechanization); and an increase in yield as a result of better input use.

These changes in rainfed lowland farming practices and the changes in land productivity has a bearing on the farm household's expenditure behavior. Where farmers are almost net rice "purchaser" in the pre-adoption period, farmers are net rice "seller" after the post-adoption period. The study also implies that changes in production output rather than rice price changes have positive effect on the increase in marketable surplus.

The study further showed that relative shares of income sources have changed but consumption pattern remain the same.

IN SEARCH OF SUSTAINABLE FARMING SYSTEMS: EXAMPLES FROM SMALL-SCALE IRRIGATION DEVELOPMENT IN ASIA <36

David J. Groenfeldt

Irrigation forms the basis for the highly productive agriculture of Asia. Improving indigenous irrigation systems, or developing new small-scale irrigation can provide a focus for the management of other natural and agricultural resources at the local level. This paper examines the experience of several recent and ongoing projects in Asia in which the irrigated farming system has been addressed at a community management level and with an explicit concern for the sustainability of the local ecosystem.

Three types of agro-ecological context are examined: (1) micro watersheds in Sri Lanka and India, (2) mountain valleys in Nepal and northern Pakistan, and (3) small river basins in northern Thailand. In each case, more productive farming systems are a function of local institutional capacity, interactions within the farming systems components (e.g., irrigated vs. rainfed cultivation, herding, off-farm employment), and local resource management (e.g., forest cover and water retention within the catchment). Sustainable farming systems and sustainable local environments are interdependent. The paper concludes with policy recommendations addressed to international aid agencies and national governments.

FARMERS HYPOTHESES IDENTIFIED THROUGH CASE STUDIES, VILLAGE MEETINGS AND GROUP DISCUSSION, ETC. <37

M. Murshidul Hoque, M. N. Alam, D. J. Costa, N. I. Shams

To understand the dynamics of diversification of skills and resources to deal with the risks inherent in the environment in Bangladesh, we need to use a method of enquiry which is participative, interactive and iterative. So the main aim of the present study is to know the farmers own views of farming system. Farmers of our country are the indigenous scientists. That is why it is essential to learn something by asking questions related to their day to day farming. Many times, people bore the idea of asking questions about the issues which to them seem very obvious. However, it is not uncommon to find instances when important directions of research were missed just because we failed to ask the right questions. So by asking questions we can learn most from the farmers. For this purpose of enhancing our knowledge for the development of new horizons in the future research program we should visit the farmers repeatedly for asking questions i.e., case study. It is to be mentioned here that the same time and energy we have spent for the purpose in the past, can hopefully generate more useful insights if we could sharpen some of our questions. For identifying the problems of the farmers and following the ways and means of solving the problems by the farmers, has been taken as the principal technique of designing research and development activities and for it case study used as a mechanism of dialogue. In this process we have identified the farming economy where existing technology would help improve their livelihood. This study was therefore essential to obtain all the information of detail farming practices, environmental and socio-economic conditions of the farmers.

MOUNTAIN FARMING SYSTEMS: SEARCH FOR SUSTAINABILITY <38

N. S. Jodha

The dominant scenario characterizing mountain (or hill) agriculture - combining varying proportions of land based activities such as cropping, animal husbandry, horticulture, forestry etc. -in Hindu Kush-Himalaya (HK-H) ration, reflects symptoms of unsustainability. (A few of the indicators of unsustainability include increased extent and frequency of land slides and mud slides, reduces extent of waterflows, deterioration in the vegetative make up of forests and pastures, increased periods of seasonal scarcities of food, fodder, and fuel, decline in yields of major crops, reduced diversity and flexibility of mountain agriculture, general decline in employment and income, and increased out migration of hill people.) Given its basic characteristics and current pattern of use, the agricultural resource base seems unable to protect (regenerate) itself and also produce enough to satisfy current as well as rising future needs of mountain people. Understanding of the factors and processes contributing to unsustainability is an essential step for identifying possible options to reverse the above trends. This is being attempted by ICIMOD under its Mountain Farming Systems Programme in HK-H region. The work initiated in selected mountain areas of China, India, Nepal and Pakistan involves both knowledge

reviews and field studies of crop, livestock and horticulture dominated farming systems. The relevant public interventions as well as farmers' strategies are examined with a focus on their implication for sustainability. This paper presents some of the preliminary results of the studies.

The first step in the investigations is preparation of an inventory of indicators of unsustainability. These indicators may relate to the negative changes in the resource base, production flows and the resource management and usage practices. More importantly they are grouped under following three categories on the basis of form and level of visibility of the change.

(I) Directly visible negative changes as illustrated by increased extent of land slides, deterioration in vegetative composition of forest and pasture, decline in water flows, decline in yield rates of mountain crops, reduced diversity of mountain agriculture etc.

(II) Negative changes made invisible due to people's adjustment responses which hide the former. Adoption of shallow rooted crops substituting deep rooted crops following erosion of top soil on mountain slopes or introduction of public food distribution system to meet the situation created by widened inter-season hunger gap following the reduced crop production etc. fall under this category.

(III) Some of the changes in the form of development activities as public interventions or as farmer's strategies, initiated in order to meet present as well as perceived future shortages of products at current or increased levels of demand. Such changes, in the long run, may bring about negative results because of their insensitivity to mountain specificities and their implications. The mountain specificities include inaccessibility, fragility, diversity, marginality, etc.

To illustrate, any farm technology which increases mountain agriculture's dependence on external input or leads to massive production of high weight low value product, may not add to sustainable development due to inaccessibility and its associated problems. Similarly, any measures disregarding fragility of mountain slopes and ignoring linkages between diverse activities at different elevations (e.g. farming-forestry linkages) may not ensure sustainable development. The study assembles a large number of development interventions at macro and micro level and analyses them with reference to their sensitivity to mountain specificities.

The analysis of the factors and processes generating the indicators put under the above three categories shows close links between incorporation of mountain perspective in an intervention and its consequence in terms of sustainability/unsustainability. The study helps in identification of elements with sustainability potential for mountain farming systems.

39> EXPERIENCES WITH FARMING SYSTEMS IN BANGLADESH

Mafizal Haque Khan, Q. M. Emdadul, Rajesmwar N. Mallick

Although Component Technology research in farmers' fields was initiated in 1958 in Bangladesh the system basis research could be initiated only in 1974 with a cropping system bias as crop contributes as high as 36.8% of gross domestic product. Existing cropping systems were studied. More than 90 improved and alternative potential cropping patterns were designed, tested and evaluated in terms of biological and socio-economic parameters. As many as 21 superior cropping patterns were packaged and recommended for dissemination in the recommendation domain.

As livestock contribute 6.5%, fisheries 3.7% and forestry 3.1% of the gross domestic product the farming systems approach including all important farm components became a major thrust of agricultural research in Bangladesh for generating sustainable improved technologies since 1985. Farming systems research has recently been broadened to include on-farm trials with animals, particularly large ruminants which primarily provide draft power for the production of crops and secondarily milk, meat and hide for domestic consumption of crops and cash income. Also included in the farming systems research program are agroforestry and pisciculture to a limited scale. As over 50% of households are landless so the homestead production system research was initiated to fulfill vitamin deficiency as well as utilize unused human resource. Poultry, beekeeping and multipurpose trees plantation were included in the research besides intensive vegetable cultivation to provide vegetables throughout the year. The complex farming systems of the country, organizational infrastructures of research and extension, methodology, approach to farming systems research and its scopes and opportunities with indication to the future thrusts have also been described.

40> FARMER PARTICIPATION IN FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E): A MEAN TO SUSTAINABLE AGRICULTURAL DEVELOPMENT

Waqar Malik

A growing body of the literature supports the notion that the past agricultural development strategies have been less sustainable and this is reflected in the crises of our time. The recent famine in the Sub-Saharan Africa, enormous degradation in natural resource base and alarming pollution in environment in the U.S. and other parts of the globe present a vivid testimony to this effect. Such a situation calls for drastic changes in the whole spectrum of agricultural research-extension-production systems. These changes can never occur unless the man behind the plow – farmer – develops a sustainable thinking and adopts sustainable farm practices. Thus, emphatic participation of farmers in FSR/E is one of the chief solutions to achieve sustainable agricultural development.

This paper discusses some of the key issues involved in and the constraints impinge on seeking small farmer participation in FSR/E, and proposes some potential strategies to attain people participation that promises sustainable agricultural growth.

41> FSR/E - INDUSTRY LINKAGES TO MAXIMIZING PROFITABILITY OF SMALL FARMERS - A CASE STUDY OF PSYLLIUM CROP SYSTEM IN INDIA

D. P. Mathur, A. D. Shinde, S. N. Chokshi

The basic premise of this paper is to examine futuristic role of FSR/E by incorporating into its framework, farm product processing to achieving the goal of maximizing profitability of the small farmers in a crop enterprise of high risks and grown under weather uncertainties. This would also involve active participation by the farmers in the developmental processes. In fact, the present exercise, attempts to extend Susan Poats model of FSR/E which was based on diagram by Collinson.

For illustration, Psyllium seed crop raised in Semi-Arid lands was specially chosen. The crop being of French origin, was successfully adopted for commercial cultivation in India in early Nineteenth Century. Psyllium seed had medicinal value and its formulations were acceptable in about 90 countries. FSR/E identified the problems of low productivity. Scientists developed new strains and improved package of practices which were adopted successfully by the farmers. As a consequence land productivity increased by 19 percent over a period of 30 years. However, there was no assurance to about 45000 farmers raising the crop to accrue monetary gains in proportion to their productivity enhancement efforts due to market imperfections. Importantly, large proportion of the Psyllium Seed raising farmers were small farmers (owning less than 2 hectares of land) and had also limited capital base. Based on cost concepts of Farm Management studies, farmers had mere net income of US $ 153 per hectare from Psyllium seed cropped area in 1988-89.

However, it is contended that if present efforts of FSR/E were linked with the available processing technology in the voluntary organizational framework, the monetary gains itself would be US $ 308 per hectare. Also there world be opportunities to further increase above gains on the basis of processing by-products. The

voluntary character of the organizational framework will also provide opportunities for the additional welfare gains in the field of health care, education, training, recreation, etc.

FARMING SYSTEMS RESEARCH/EXTENSION LINKAGES AND INSTITUTIONAL DEVELOPMENT: CENTRAL PHILIPPINES EXPERIENCE <42

Belinda K. Navascues

This is a compilation of the different phases and processes included in a regional institutional capability building project and how Farming Systems Research and Extension served a conduit of a series of stable and sustainable developmental changes. Most materials are gathered from experiences of the Central Visayas Regional Project, an Integrated Watershed Research and Development Project, funded by World Bank and the Philippines government.

Included in the paper are illustrative diagrams that depicts the different schemes implemented in various institutional levels. Diagrammatic flow charts are incorporated that presents the direction, coordination activity, location and participants in the project. It also indicates the different roles of key actors, advisory and executive committees, monitoring and evaluation groups as well as group on training and documentation. It emphasizes the degree of responsibilities of the researchers, extension-workers, farmers and private sectors.

The main feature of the paper is the evolution process of an integrated institutional strengthening approach where multi-agency-interdisciplinary task forces when formed and made to inter-play provided a stronger, more stable and sustainable network of expertise readily available and appropriate to the complex, multi-faceted agriculture-based problems prevailing in every institution in a given agricultural area. It vividly illustrates how participating members in a task force are able to tackle socio-economic conflicts with the use of simple viable Farming Systems Research models made available at the soonest possible time at least cost to the government.

It show how support services are provided by the government and the private sectors with the former decreasing and the latter increasing in responsibilities as a given technology matures.

Progress and success is evaluated in terms of the number of project replications done by government institutions and the non-government organizations within and outside the Central Visayas region of the Philippines.

THE RELATIONSHIP BETWEEN INDIGENOUS RICE TAXONOMIES AND FARMERS' RICE PRODUCTION DECISION MAKING SYSTEMS IN SOUTH INDIA <43

B. Rajasekaran, D. Michael Warren

Rice is the predominant staple crop in most of south India. In spite of advancements in the field of transfer of technology, there still exists a wide gap between farmers' preferences and recommendations from the agricultural research and extension services. The neglect of the farmers' body of knowledge on local rice taxonomies by agricultural research and extension staff resulted in the dissemination of a number of rice varieties which lack sustainability in the local farming conditions. Inadequate understanding of the indigenous decision making systems of farmers in selecting a rice variety has been found to be one of the causes for the development and extension of rice varieties which are not preferred.

In this paper, the dissemination and utilization process in the Training and Visit (T&V) extension systems in south India was analyzed to identify the knowledge and utilization of local rice taxonomies of farmers by extension personnel. The local taxonomies of rice varieties cultivated in rice based farming system villages of south India were found to be classified according to four criteria: (1) source of irrigation water, (2) cropping season, (3) crop duration, and (4) grain quality. It was also found that the rice taxonomies formed the basis for the decision making systems of farmers in these farming systems. The criteria which influence the decision making process in selecting rice varieties from local taxonomies were identified.

Policy suggestion to incorporate local rice taxonomies into the T&V extension system are formulated. The impact of understanding local rice taxonomies on the timely availability of preferred rice varieties in seed centers is explained. Understanding local rice taxonomies by extension personnel would help them in communicating with seed center personnel for the raising of seed farms for preferred rice varieties. The importance of decision-tree games in identifying the factors affecting farmers' decision making systems in selecting a variety is discussed. Working with and through indigenous agricultural knowledge and decision making systems would improve the sustainability of small and marginal farmers in rice based farming systems of south India and other developing areas.

HUMAN RESOURCES DEVELOPMENT AS A KEY TO THE SUCCESS OF FARMING SYSTEMS RESEARCH IN INDIA <44

Kavasseri V. Raman, Thangiah Balaguru

Despite the tremendous progress made by India in agriculture during the last decade and a half, technologies recommended by the researchers are not being adopted in their entirety by the resource-poor small farmers. This has arisen essentially because the technologies themselves are inappropriate to the farmers' circumstances. Realizing this, the National Agricultural Research System (NARS) in India is currently directing its attention to a better understanding of the conditions and problems of these farmers to ensure that programs and policies developed keep their constraints in mind. Consequently, more and more research activities are oriented towards Farming Systems Perspective (FSP) on the lines of FSR. The FSP part of the FSR is not always well developed among the Indian scientists and it has become an important task of the NARS to try deliberately to promote it. Although India is having one of the largest scientific manpower in the world engaged in agriculture, it is still short of scientists with adequate farm level experience that FSR demands. Attempts are now being made by the NARS to pay adequate attention to Human Resources Development (HRD) in order to create and sustain the interest of scientists in the complex, more demanding, holistic approach like FSR. Some of the efforts made in this direction are discussed in this paper.

The National Academy of Agricultural Research Management (NAARM) is playing a major role in promoting the FSR philosophy among the Indian scientists as well as in equipping them with the required knowledge and skills to undertake FSR-related research activities. For bringing about attitudinal changes in the scientists, NAARM has taken several innovative steps. In a simulation game like "Green Revolution" conducted at NAARM, the scientists by assuming the role of resource-poor small farmers, are able to understand and appreciate the necessity for considering the farmers' circumstances in the technology generation and dissemination process. The FSR diagnostic procedure through rapid appraisal techniques consists of a set of skills which one must learn, and should not be considered as something anyone can do. Systematic learning form farmers is not a critical part of professional training in India. Realizing the fact that development of appropriate technologies depends critically on the style and quality of face-to-face contact with farmers, NAARM organizes field experience programs as an integral part of its training of scientists. Under this, it becomes mandatory for the scientists to visit rural areas and conduct exploratory survey by interviewing the farmers using standard schedules in order to collect data pertaining to physical, biological and socio-economic aspects having a bearing on agricultural production. This experience gives them an opportunity to understand the needs, aspirations, resources and constraints of farmers,

and enables them to develop relevant research projects.

Multidisciplinary team of social and biological scientists working together are normally advocated for FSR. In India, almost all research programs embracing the FSR philosophy face a major problem of bringing about multidisciplinary cooperation among scientists. Specialized training programs are being proposed by NAARM on how to work in a multidisciplinary team so that the scientists view the final outcome as a joint effort in which all have participated and for which all are equally responsible. Towards meeting the specialized requirements needed for conducting on-farm research, special training programs are being organized by NAARM on the diagnosis, design, implementation and evaluation of on-farm research. Scientists involved in extensive on-farm activities also face difficulties of acquiring professional rewards and status. Efforts are being made in India to suitably modify the performance appraisal system for the agricultural scientists, thus motivating them to move out more and more from the research stations onto the field and work in close collaboration with farmer clients. In addition, the CGIAR International Center - ICRISAT and the Asian FSR Network are also playing a major role in promoting the FSR philosophy in India through training and improving communication among the scientists.

45> METHODOLOGIES FOR ASSESSING IMPACT OF FSR/E - EXPERIENCE IN AN ASIAN CONTEXT

Nimal F.C. Ranaweera

The last two decades have witnessed the proliferation of a number of research projects within the broad framework of FSR. Consequently this approach has been utilized as a vehicle towards agricultural development planning and as a means to increase production. This necessitates impacts on production, incomes, consumption patterns and life styles of farmers. The impacts can be positive, negative or neutral.

With the increasing social and political issues pertaining to equity and resource distribution among farmers, the need to measure real impact of the new FSR technology becomes important. Number of parameters can be used to measure impact, e.g. changes in output and real income per unit of land or farm, changes in wage rates and migration patterns for labor, changes in factor markets particularly land which becoming a scarce resource. Changes in consumption patterns, improved nutrition, higher educational attainment among farmers' children are also measures of the impact of new farm technology.

A number of analytical techniques have been used in trying to quantify all or some of the above identified parameters. A two year study undertaken by 4 Asian countries (Bangladesh, Indonesia, Sri Lanka, Philippines) in 7 study sites to measure impact of FSR was completed in 1988. The results show that the different approaches ranging from partial budgets to regression analysis can be used to measure impacts of the new technology.

The paper will critically review the existing methodologies and the results obtained from the data used in the 4 country study and discuss the methods use in these studies. It will also surface some of the issues pertaining to data management, software development and problems associated in aggregating farms of different size and other factors.

46> FSR/E APPROACH TO INCREASED FARM PRODUCTIVITY: THE CASE OF THE CROP-ANIMAL FARMING SYSTEMS RESEARCH SITE IN STA. BARBARA, PANGASINAN

Roberto Ranola, Jr.

The FSR/E approach is a whole farm approach to the development of a stable and economically profitable agriculture. The approach at the crop-animal farming systems research site at Sta. Barbara, Pangasinan follows two reduction of the cost of production as well as the generation of additional revenues - both farm and off-farm.

There are two interrelated approaches by which farm costs can be reduced as well as additional revenues generated. The approach involves initially an understanding of all the activities and the flow of farm resources. This facilitates the identification of the bottlenecks in production and thus the opportunities to enhance farm income.

These approaches are followed at the Sta. BArbara site. It involves looking into both the on-farm and off-farm activities and resource flows. the on-farm components include the introduction of new crops into the cropping pattern. For example, cowpea and mungbean were introduced after rice where originally land lay fallow. Alongside, component technologies were also introduced to optimally utilize farm inputs. Component technology studies include the study of fertilization rates and herbicide application.

Another revenue increasing and resource optimizing activity introduced was livestock. Livestock was introduced to utilize crop by-products. further, it was expected that animal wastes could be utilized by the crops. The activities included were cattle fattening, draft power improvement and animal health care. The traditional 'paiwi' system of hiring labor for fattening cattle was adopted. Hired labor would be paid through the sharing of the profits from the sales of the animal. The introduction of livestock however created a new constraint - availability of feeds. The condition is difficult in places where space for growing weeds for feeds. Trials were then conducted to introduce weed species grown in areas normally left idle.

The off-farm components included a consideration of the present utilization of labor - men and women - for off-farm work. A special study was conducted to look into women's concerns and introduction of technologies to utilize more fully their labor. Important results included the introduction of livelihood projects such as mushroom growing and the glutinous rice project.

A whole farm economic analysis was conducted to look into the whole farm resource flows and activities to identify profitable enterprises. This considered both on-farm and off-farm enterprises. It was then possible to consider the competition for resources and include in the equation of the farms' decision-making process.

a marketing study was conducted to determine the market for important commodities produced by the target farmers. This is very important for deciding what farm commodities can profitably be produced by farmers.

The whole farm approach followed at the Sta. Barbara, Pangasinan site has a very important implication. The experience at the site shows that to attain a more stable and profitable farm production and increased family income it is necessary to utilize a complete rather than a partial approach. Often, the failure of introduced technologies results from a lack of a holistic picture of farm resource flows and activities.

47> THE ROLE OF FARMING SYSTEM RESEARCH IN SUSTAINING PRODUCTIVITY AND PROFITABILITY IN VAISHALI DISTRICT OF BIHAR, INDIA

Satguru Saran, Prahalad Mishra, Ajay Kumar, Ahmed Salman

Bihar State is predominantly a rice growing area with the largest rice acreage (5.4 m.ha.) in India. Current rice productivity is around 1.1 t/ha. against national average of 1.6 t/ha. Nearly 30% of the total rice area is irrigated and modern technology developed in the recent past caters mainly to this situation . Little work has been done for the 70% rainfed rice system. The crop is grown under highly diversified agro-ecological situations.

The agricultural research stations in Bihar are well developed. Trials conducted in the station are more suitable for irrigated conditions. Given this situation, on-farm research project supported by the Ford Foundation was initiated in Vaishali district of Bihar in 1985. The primary objective was to develop improved technology for rainfed lowland rice based farming system for the resource poor farmers. Interdisciplinary on-farm research was conducted which

included work on varietal improvement, agronomical practices, plant protection measures and socio-economic studies. After two years of research it was realized that development of agricultural technology for rainfed rice system will take more time than expected and it is risk prone and not sustainable. Hardly one in 5 years cycle do farmers get a good crop of rice. In other years it is either a complete failure or partial success which all depend on the vagaries of natural hazards like drought or flood. Resource poor farmers have small land holdings and are extremely poor. Their dependence on rice based cropping system alone is mainly responsible for their poverty.

Keeping these factors in view the concept of Farming Systems Research was adopted. The work began in 1987. In this paper, highlights of the impact of FSR/E programs in Vaishali district on productivity and profitability in a typical agro-ecosystem and socio-economic setting have been presented.

Agro-Ecosystem and Socio-Economic Profile:

The project site has a total area of about 2000 ha. The annual average rainfall of nearly 1000 mm. is highly erratic and unpredictable. Three major agro-ecosystems are (i) rainfed upland (10% of the area), (ii) shallow rainfed lands (20% of the area), and (iii) deepwater lands (70% of the area). Rice is the predominant crop during wet summer season. Wheat, oilseed and pulses are important crops during winter season. Fish culture is characteristic of the deepwater lands. Current fish productivity is low i.e. 05. to 0.7 t/ha. per annum. Cows, buffaloes and goats are important livestock reared by many families. The productivity of agricultural crops is very low. Milk yields of cows and buffaloes are poor. Goats are reared for only meat purpose.

Agro-ecosystems are dependent upon a variety of socio-economic factors like land holdings and its distribution, primary occupation and household income of different economic groups. A remarkable feature of the land holding is that 90% of the total cultivatable land is water logged (shallow and deep) and only 10% is upland. A high degree of concentration of land holding is with high cast households who constitute only 30% of the total households. Of the total households 90% (both high and low caste) are either marginal/small farmers or landless laborers. Most of the households depend on agriculture and agriculture wage earning. Occupationally 65% of the total households are cultivators, 15% landless laborers, 6% artisans and 14% service class businessmen or traders. Agricultural income from deepwater lands is highly uncertain and depend on a variety of factors such as rainfall, floods, drought, insect pests, etc. Only 40% of the agricultural income comes from 90% of the land which is under water-logged condition during a major part of the year. But 60% of the agricultural income comes from the upland which is only 10% of the total land.

The farm income consists of income from crop production (all crops), milk production (cows and buffaloes), fish harvesting, goat rearing etc. The non-farm income consists of wages, salary and profits from business and trade. however the major sources of income of the resource poor households consists of agricultural and non-agricultural wages tobacco processing, fishing, dairy product, goat rearing etc.

In this highly complex farming system having a high risk prone yield and with such a socio-economic setting we find a low percentage of sustainable yield in this area. Thus our priority research goals in the FSR/E are to increase output (both agricultural and non-agricultural) for home consumption and for the market. This paper presents data to quantify productivity and profitability of a number of experiments conducted with respect to different target groups (socio-economic groups). Some of the trials have been very successful. The results and recommendations of such trials have been accepted and adopted by large number of the farmers including the resource poor farmers, in the project area.

Findings on Sustainable Productivity and Profitability:

(1) Estimates of the cost and returns from different mixed cropping trials in rainfed lowland conditions were worked out. Rice & Jute combination gave maximum net income of Rs. 5531 ($370 U.S.) per ha. while income from rice & mungbean and rice alone was Rs. 4184 ($280 U.S.) and Rs. 1012 ($68 U.S.) per ha. respectively. It was observed that in the chaur agro-ecosystem very high risk is involved in all the combinations of mixed cropping and mono-cropping. However, income from rice & jute is comparatively more assured than rice alone. There has been substantial increase in rice & jute area during the last 2 years and is productive as well as sustainable. This combination results in the optimal use of available labor force with increase in the labor output ratio.
(2) Sysbania aculata crop is basically grown for fuel purpose. Although it is a good crop for green manuring. It is ideally suited for water logged fields. Another species Sysbania rostrata was tested and found more vigorous and sturdy. It yields more biomass for fuel purpose. Production of this crop has expanded rapidly. In view of the fuel shortage in the area and its suitability to water logged fields this variety is bound to stay in the local agro-ecosystem.
(3) The traditional rainfed lowland rice is not only risk prone but has a longer crop cycle (March to November & December). Short duration rice crop during dry summer (risk free period March to June & July) was tested and found quite suitable for the area. This crop requires 4-5 irrigations. There is no dearth of water in the area. IET 3279 rice variety was found most suitable as a dry season crop. Farmers are adopting this type of cultivation which was unknown in the area.
(4) Basal application of fertilizer to rainfed lowland rice @ 20 kg N & 40 kg P_2O_5/ha. at seeding time increases the yield by 30%. This crop withstood drought and flooding better than the control crop. Fertilizer application is not practiced in the local lowland rice and has great future.
(5) Fodder crop berseam (Trifolium alexandrinum) has successfully been cultivated in the shallow lands during November - April after the harvest of rice crop. This practice is catching up with the farmers. There is great scarcity of fodder in the area. It will also help in increasing milk production of cows and buffaloes.
(6) Improved wheat varieties HP 1490, BR 346 and HUW 234 have been adopted by the farmers in a big way. These have been identified from a wheat trial conducted recently. Wheat productivity has increased from 1.5 to 2.0 t/ha.

FUTURE PLANS

Recent work has revealed that tremendous potential exists to develop FSR/E in the project area. Some of the salient features of the future plans are:

(1) Development of scientific fish culture.
(2) Sustaining research on various aspects of agriculture and animal sciences including wheat and mustard cultivation in puddled field. Exciting possibilities are there for this type of cultivation.
(3) Improvement in existing infra-structure responsible for the supply of agricultural inputs so as to assure their timely and adequate supply.
(4) Continuation of research on social and economic aspects which will help in deciding future research and development priorities.

ASSESSMENT OF IMPACT OF FARMING SYSTEMS RESEARCH IN TWO SELECTED SITES OF BANGLADESH <48

M. R. Siddiqui, R. Islam, A. H. Khan, N. P. Magor, M. Hossain

The extent of adoption of farming systems technology and its impact on farm productivity, farm income and consumption pattern was assessed at two rainfed lowland sites in Bangladesh during 1987. The sites were Kamalganj in the north east, which is rice surplus and characterized by remoteness, and Sitakunda in the south east, which is rice deficit but has ready access to major markets. The cropping patterns recommended for the two rice crop systems covered varietal sequence choice, timing and fertilizer

levels; and allowed for variation in the onset of monsoon, landtype and draft and labor availability.

Sixty farmers, weighted by landsize, were randomly selected from six to eight villages at each site. Villages were identified according to landtype. Farm families were monitored daily over nine months for all household income and expenditure and crop production activities. Food consumption was assessed before and after the harvest of the main rice crop. A farmer, who cultivated over 60 percent of his land area to the recommended sequence of varieties was classified as an adopter in the initial analysis.

In Kamalganj adopters achieved over 600 kg/ha more total production and a higher net return than non-adopters. However, fertilizer level was approximately one third the recommended. For Sitakunda adopter production was 1880 kg/ha higher than non-adopters and net returns were similarly higher. Adoption at Sitakunda for cropping sequence was lower than Kamalganj but fertilizer levels were higher as was subsequent total production per hectare. For both sites expense on eduction was significantly higher for adopters and on loan repayment it was significantly lower. It cannot be concluded whether this was the result of the new technology. The income base from other farm enterprises and off farm employment was far higher for Sitakunda with rice production only contributing 27 percent of total income compared to 58 percent for Kamalganj. Cash investment in agriculture was four times higher in Sitakunda and production and income per unit land were also higher. The level of credit for agriculture was negligible at both sites. This may have been offset at Sitakunda by the more diverse cash base, but in Kamalganj the cash squeeze resulted in a lower production level. The contribution of home produce to energy and animal protein consumption was higher in Kamalganj and slightly above recommended levels. At Sitakunda energy consumption appeared to be lower for non-adopters.

Limitation and constraints of the study are discussed. An implication of the results of the study are that for sites dominated by a single income source such as rice production, crop diversification and development of other enterprises may be important components to both increased production and income for farmers. Including these credit, marketing and intrastructural systems should also be developed. The study is going on for the next three years to examine the sustainability of the technology.

49> INSTITUTIONAL STRUCTURES TO PROMOTE FARMER PARTICIPATION IN FSR/E PHILIPPINES CASE

Ly Tung, Raul Repulda, Clive Lightfoot

Many research and development specialists cogently argue that more participation from farmers is needed in FSR/E efforts if the technical problems of resource poor farmers are to be appropriately addressed. Recent conferences and workshops have elaborated techniques for improving farmer participation in FSR/E, but serious institutional barriers remain. This is especially so where institutions are built on Transfer-of-Technology procedures in research and Training & Visit strategies in extension. This, all too common, institutional framework frustrates critical participatory activities. Listening to farmers is hard where researchers dominate the determination of research agendas. Taking a wider multidisciplinary systems view is hampered where research is organized on commodity or disciplinary lines. Giving farmers leading roles in experiments and extension is difficult where researchers and extensionists are expected to have all the answers. This paper recounts how a farming systems development effort has changed research and extension institutions in the Eastern Visayas, Philippines to improve the way farmers are involved in the research and extension process.

New functions in listening to farmer problems, searching for solutions, farmer participatory experiments and farmer-to-farmer extension performed in new institutional structures of village based multidisciplinary research and extension teams in the Department of Agriculture (DA) backed up by a new small University based institution (Farm and Resource Management Institute - FARMI) performing new functions in FSR/E training, and bottom-up research planning for on-station research create an institutional environment that promotes farmer participation in research and extension process.

Institutional innovations in functional structures show how farmers, DA site teams, extension service and FARMI first listen to farmers and diagnose their problems. Imperata grass infestations which highlight the systems nature of problems will exemplify this function. The second function in this "bottom-up" process is a search for appropriate solutions using Indigenous Technical Knowledge and conventional sources. Indigenous preparations of livestock de-wormers illustrate this function. The search is followed by farmer participatory experiments. Legume live-mulches a potential solution to declining yields for shifting cultivators exemplifies this function and highlights the importance of low-external-input solutions. Successful solutions, like our example of contour hedgerows, are disseminated through farmer-to-farmer extension. Where solutions are not performing well, or not fully understood FARMI facilitates the initiation of on-station research programs at the University or DA research on Psyllid damage to Leuceana is used to illustrate this function.

New organizational structures show the innovations required to carry-out those functions that promote farmer participation in research-extension processes. New structures are the addition of DA research and extension teams at the Municipal level and a formal linkage with the University through FARMI and the Regional Research Division. Informal linkages with Non-Government Organizations were also found to be important. How structure works in terms of lines of administration and technical advice emphasizes the importance of short non-degree courses in FSR/E and mobile "on-the-job" training to reorient and retool DA research and extension staff.

These new institutional structures and functions promote farmer participation in agricultural research and development. In the long term they build "bottom-up" research priority setting processes which ensure that on-station research becomes more relevant to resource poor farmers. The multidisciplinary problem foci leads to the development of low-external-input agricultural technologies appropriate to resource poor farmers. Finally, self confidence among farmers, researchers, and extensionists grows as farmers take more leadership and others more supportive roles in the research and development process.

50> CHANGING FARM CROPPING SYSTEMS FOR SUSTAINING FOOD AND NUTRITION SECURITY IN INDIA

Harwant S. Uppal, K. S. Gosal

India is predominantly an agricultural country. Though about 75 percent of the population is directly or indirectly involved in agriculture, it is not self-sufficient in agricultural production. About 40 percent of its population is either under-nourished or malnourished. The population of the country is expected to cross 1000 million by the year 2000. The food requirement alone will be 250 million tons by the end of the century. The food grain production has to be increased by at least 60 percent from the existing resources level. Thus, we are entering a difficult but exciting phase in agriculture. Sustainable nutrition security will be possible if the use of natural resources is done in a manner that the short and long term goals of development are in mutual harmony. Generating a system approach both at the planning and at the implementation levels is not an easy task. Without it, however, we will not be able to meet successfully the challenges ahead. It is general observation that cropping systems followed by farmers is more traditional. The farmers are slightly resistant to modernization, the reasons for this being (1) necessity of meeting basic household needs, (2) non-availability of better alternative crops, and (3) non-availability of marketing infrastructure. Sustained and conscious research efforts

have to be made to have crop belts based on the agro-climatic requirements. This necessitates an interdisciplinary approach to identify, analyze and synthesize the available resources to develop efficient cropping systems taking into consideration soil types, environmental features and climatic parameters. Income to individual flows from ownership of assets and farm employment. The basic reason why the rural people have low income is that they possess little or no cultivable land due to the process of continuous fragmentation of holdings from generation to generation. Among the holdings the land is most important and productive asset in rural areas.

Given equal access to the credit and material inputs, the farm enterprize could yield more output per land unit through cooperative and joint holdings. Such systems should be encouraged. It is becoming increasingly clear that the post-green revolution phase of agricultural development requires a very different and, in many ways, more challenging approach. This is partly because a fine grained agriculture, with technology specifically adopted to individual agroecosystems, will be impossibly demanding in terms of labor, resources and time, if the traditional linear model approach to implementation is adopted. However, there is also a more fundamental difficulty. It is virtually impossible to show the beginning of farming systems research from outside, to optimally design a whole cropping systems, for a whole farming system or for an individual farm. Only the farmer can carry out the final optimization, because only he or she has access to much of the information, including essential details of local environment, the local culture and his or her real goals. The research and development worker has a great deal to offer and can bring about highly significant changes, but in the final analysis there is a limit beyond which advice is either irrelevant or counter-productive. Increasingly, agricultural research and development and extension in this country is going to approach the patterns now predominating in the west i.e. a situation in which each farmer is presented with a "super market" of package technologies from which to choose, and out of which he or she produces an optimal farm design. The important task that faces those responsible for research and development policy is thus to ensure that the individual packages in the "super market" have arisen by way of the processes of analysis, design, assessment and development that can be integrated by farmers into their farming systems, will help to fulfill the goals of an agriculture that is not only more productive, but is more sustainable and equitable. The manuscript presents identification of the problems being faced by peasantry in the present farming systems, analyzing the reasons of non-sustaining production levels and evolving packages of cropping systems for the individual or whole farming systems under the varying agroeco regions of the country.

LINKAGES: KEY TO INTEGRATE INSTITUTIONS AND INCREASE FARMER PARTICIPATION <51

Mahinda Wijeratne

Advancement in technology, specially the knowledge generated in the green revolation, accelerated agricultural development. However, it is evident that research (through technology development) has taken control over the future of the farming environment, limiting utilizer control over the development of farming systems. In many instances, farmer's knowledge (traditional knowledge) is not considered in a serious manner and as a result, farmers are alienated from the decision making process. All t he decisions on farmers were taken by policy makers and scientists. Farmers were expected to implement these decisions according to the instructions. In fact, this is the essence of the to down Transfer of Technology (TOT) model. Today, we are more interested in farmer participatory approaches such as Farming Systems Research (FSR), participatory methods of technology development, integrated rural development projects etc. Such approaches make efforts to link research, extension and utilizers to cover a wider range of activities and further, consider user control in some form is an essential ingredient for an effective agricultural system. New development in Agricultural Knowledge System (AKS) conceptualizations is much concern for relationship between various elements in science/ practice continuum. This concept can be utilized to narrow the existing gaps between research - extension-utilizer sub-systems. In fact, one of the major objectives of FSR is also to integrate various institutions in an agricultural system. There fore, AKS concept can make a vital contribution to FSR, specially in the context of strengthening linkages. Based on an empirical research carried out in Sri Lanka, this study presents the facts concerning existing linkages between research-extension-farmer in the production sector.

HOMEGARDENS AND CORN FIELDS: A CONTRAST OF SOIL CONSERVATION STRATEGIES AMONG UPLAND FARMERS IN THE PHILIPPINES <52

Eva Wollenberg

Soil conservation programs tend to disseminate technology packages designed for the "generic" field. Although such packages may be appropriate for selected fields, they are often inappropriate for other sites cultivated by the same household. A 1988 survey of 200 upland households in Negros Oriental, the Philippines, shows that farmers used strikingly different techniques of soil conservation on different fields, depending on each field's management constraints. This paper contrasts management constraints and corresponding soil conservation practices for homegardens and corn fields. Management differs in terms of capital outlays, labor requirements, role of livestock, mix of organic and inorganic inputs, risk tolerance and scale of production. Differences in soil management are also associated with household socioeconomic attributes, including land tenure, income status, urban linkages. Results are presented within the framework of a decision making model indicating farmers' criteria for making coil management choices. Understanding within-farm differences in farmers' soil conservation strategies should be an essential first step for the identification of development opportunities in farming systems research.

PRODUCTIVE CAPABILITY OF RICE-SHRIMP SYSTEMS FOR ESTUARY AND FRESHWATER AREAS OF VIETNAM <53

Vo Tong Xuan

Text unavailable at publication date.

REGIONAL SESSION: LATIN AMERICA

54> MAJOR CONSTRAINTS TO THE USE OF HERBICIDES BY SMALL FARMERS IN TRINIDAD

Richard A.I. Brathwaite

Small farmers have recognized weed control as the most important single constraint to efficient food crop production in Trinidad. Often the use of herbicides has been recommended as a possible solution to the problem. Data from a 2-year study amongst selected small farmers have identified many constraints in the farming area, the small size of farmed plots, the frequent practice of mixed cropping, the marketing of herbicides and socioeconomic factors. Strategies to overcome these major factors, including the results of on-farm research trials, are discussed and areas for further research are highlighted.

55> PLAN SIERRA: AGRI-FORESTRY SYSTEM (PLANTATION-COFFEE) MODEL DEVELOPED BY PLAN SIERRA IN THE CENTRAL MOUNTAIN RANGE OF THE DOMINICAN REPUBLIC

Camilo Camacho, Luis Eduardo Peralta

In our paper we will give a detailed description of the agri-forestry system (Plantation-Coffee). This production model has been developed by the Plan Sierra in its area of influence in the Central mountain range of the Dominican Republic . During the ten years of experience in developing this system, data have been obtained which indicate its relevance from an ecological and economic point of view.

The agri-forestry system is based on the development of coffee plantations (Coffea arabica) as the main component which are integrated with other short-cycle crops. The objective of these crops is to produce income and food for the family until the coffee is ready to be marketed. The coffee trees are also combined with banana trees (Mussa sapientum) and guama (Inga vera) to provide provisional and permanent shade, respectively. The Corazon de Paloma (Columbrina arborescens) is also planted in order to use the vertical space to produce wooden poles and posts.

As well as the coffee component, this system includes a permanent plantation. Once the coffee trees have been developed a mixed garden is set up with various fruit trees and vegetable plants for the families. There is also an animal component made up of a cow pig and chickens.

The minimum area for the development of the system for an average family of six members is 35 hectares. The graph which follows shows how the peasants have developed the system under the guidance of Plan Sierra.

56> INCORPORATING INDIGENOUS KNOWLEDGE SYSTEMS INTO THE ON-FARM CLIENT ORIENTED RESEARCH OPERATION IN LATIN AMERICAN COUNTRIES

Xenia L. Ceville, B. Rajasekaran

On-farm client oriented research operations (OFCOR) is an approach to help researchers meet the needs of specific clients: subsistence farmers. In the late 1970s the Instituto de Investigacion Agropecuaria de Panama (IDIAP), developed a national plan through which priority areas for on-farm research were selected based on priorities established by the Ministry of Agriculture of Panama. It was found that the indigenous knowledge used by farmers, systems which are their basis for decision making, was not considered in the OFCOR. Social aspects directly related to indigenous knowledge were a factor that was not included in the research planning system.

Problems created by a lack of attention to indigenous knowledge systems in on-farm research trials are explained in detail. The neglected utilization of the indigenous knowledge systems resulted in the dissemination of technical innovations that were not appropriate to local farming conditions. Although the diagnosis of farmers' problems was emphasized in Panama, the decision making strategies of the farmers, which influences a behavioral change in them, were not given the attention required.

The purpose of this paper is to explain the significance of incorporating indigenous knowledge systems into the OFCOR operations in Panama. Indigenous knowledge systems, and related packages of subsistence cropping methods is the basis of this paper. Furthermore, strategies which are being developed to incorporate indigenous knowledge system into the OFCOR operational system of the IDIAP program planning process, in order to make the information disseminated useful for farmers will be discussed.

57> THE FSR/E APPROACH AND THE CONCEPT OF SUSTAINABLE ANDEAN AGRICULTURE

Ricardo Claverias, Roberto Quiroz

The andean agroecosystem is extremely variable, showing and "ecological mosaic" which puts together, in a shorter distance than anywhere in the world, different ecological areas with diverse productions. Therefore, the agricultural production in the andes is: difficult, due to uneven topography and extreme climates, Uncertain, with respect to production, due to climatic risks: drought and floods, frost, Fragile, where any inadequate use could produce landslide, erosion salinization.

Recognizing and understanding the heterogeneity of the andean production systems, is vital in order to propose technological alternatives that might produce sustainable development of the agricultural production. This is feasible only through a holistic research-extension approach such as the FSR/E.

The andean agricultural Systems/Research Project, searching for a sustainable development of the andean agriculture, uses the FSR/E approach. The strategy includes a detailed characterization before the generation and/or the diffusion of appropriate technologies for the improvement of productive system. In order to accomplish an adequate understanding of the andean communities, we first analyze the system of concepts that have been and are elaborated by the farmers, since these rule the decision-making process. In these concepts, called a "basic conceptual matrix", the objectives, the social and economical plans, and the technological management are organized. These concepts are depicted in collective and cultural representation: rites, myths, stories, etc. Before taking the production decisions, the andean peasants observe and analyze both external an internal factors which, together with the historical aspects, from the "basic conceptual matrix". According to these observations, two basic linkedplains are developed: 1) The socio-economical, where the peasant communities an families get together to plan the annual production and to assign labor and sites (fields) to the different production activities, according to age or sex, 2) The technological plan, where the cropping system or the livestock management is decided (for one, five and twenty years).

Once the technological management plans, which integrate the cultural, social and economical aspects, are identified, the technological alternatives are then proposed. These alternatives can be designed, evaluated and validated by, within the group of strategies planned by the types of peasants.

As a example, we show a study performed at the alpaca producing region of the highlands, between 4000 - 5000 meters above the sea level. This region shows different homogeneous production zones (HPZ): Lowlands? 'pampas', where the best native pastures and water are found, the hillside and the hills where most of the least quality pasture exists, this allows grazing for 3 or 4 months a year.

The farmers in these communities show a great diversity (table 1) They differ not only in the amount of animals and land owned but in

the quality of land, function and rationales. The peasants of the higher strata (A & B) posses a higher proportion of the most productive way. On the other hand, the peasants of the lower stratum (C) posses the least productive lands (hills) and thus showed lower production and productivity.

Since the value of their income from livestock earnings is not sufficient to meet their basic needs, the head of the household has to migrate in order to bring the outside earning to meet the difference, an the farm activity is trusted to the women, children and elders. The type of peasants have also a great influence on the capacity for adoption of new technologies . The peasants in the higher strata (A & B) showed more potential for apting practices that reduce the labor as well as those that increase the production and productivity levels. Those in the low stratum, only adopt technology that tend to reduce the labor, so they can spend more time in activities outside the farm.

In summary, the FSR/E approach is useful in understanding the complex andean agricultural system, in order to typify, by their limitations and possibilities, the different target farmers, and select the most appropriate available technologies that will produce a sustainable agricultural development.

DESIGNING BASELINES SURVEYS FOR MONITORING THE NUTRITIONAL IMPACT OF THE TRANSFER OF TECHNOLOGY IN THE RESEARCH EXTENSION AND EDUCATION PROJECT - ECUADOR <58

Kathleen M. Dewalt, William Leornard, Jorge Uquillas

Sustainable approaches to agricultural development must take into account the potential of agriculture to materially sustain the participants. The need for projects to address the issues of household food security in rural areas is germane to their success and sustainability. The Research, Extension and Education project is designed to transfer technology in three commodities: dairy production, coffee and cassava, to small farmers in several zones of Ecuador. The project seeks to address food consumption and nutritional concerns in these families and goes beyond a simplistic approach to household food production to addressing the linkages between agricultural production and household food security in project zones. In order to plan and evaluate project zones. In order to plan evaluate project activities in terms of food consumption goals a relatively low cost approach to conducting baseline surveys for the three commodity sub-projects was developed. This paper presents the approach used to develop baseline surveys to assess food consumption and nutritional problems; analysis of the nutritional systems that characterize the zones, with an emphasis on maintaining and enhancing household food security; and the implication for targeting project activities these imply

LONG AND SHORT TERM SUSTAINABILITY AND PRODUCTIVITY OF MAPUCHE FARMING SYSTEMS IN <59

Miguel Diaz, Octavio Sotomayor, Julio A. Berdegue

This paper addresses the question of the impact of an FSR/E project that was designed with a strong consideration of the sustainability-productivity-profitability issue.

METHODOLOGY

Two Mapuche indian reservations, located in the province of Cautin, in Southern Chile, were the sites of FSR/E projects conducted by non-governmental organizations (NGOs). The basic objectives were to understand the organization and functioning of the Mapuche farming systems, and to establish technological alternatives to overcome the main productive and economic bottlenecks affect these communities. The basic methodology was that which is common to most FSR/E projects, including diagnostic, technological planning and design, on-farm research and diffusion phases and activities.

However, the project also contained two characteristics which are of interest to this paper:

First, a quantitative and qualitative evaluation of the historical evolution of these communities and of each of the different types of farming systems contained therein, in order to establish how the present farming system types were formed, and to evaluate the sustainability of the local forms of agriculture since the time when the reservations were established to the present.

Second, the impact objective of this FSR/E project was to design alternatives based on the concepts of sustainability, autonomy and stability, the concept of productivity being, hypothetically, a dependent variable that could come about if the three independent characteristics were effectively established.

The impact on the project was quantitatively evaluated after four years, in two sample populations: one which represented families that had been involved in the FSR/E project, and a second one which represented non-participant households.

RESULTS

1. Different types of farming systems within communities showed different degrees of long-term (over 80 years) sustainability. Five types of present-day farming systems have derived from an original archetype (medium-large farms, oriented towards cattle production, with small-scale slash-and-burn agriculture in forest clearings).

Through time, those types of farming systems that started with a larger land-endowment, have been capable of assisting the tendency towards farmland subdivisions, and have taken advantage of the sporadic and short-term agricultural development efforts that have been conducted by several public agencies. In addition, these farming systems periods of time which are identified, by the community as a whole, as critical. Thus, these farming systems maintain an average farm size which is comparable to that which was prevalent 80 years ago, and today present a reasonable degree of agricultural and economic potential.

However, other types of farming systems show a consistent history of economic and productive deterioration, which becomes more acute during the critical periods. Also, these types have not been capable of taking advantage of the sporadic development programs that have taken place in the community.

However, all types of farming systems have been unable to maintain their stability when faced with negative stimuli of physical-biological kind. In particular, all were severally affected by the introduction and establishment of an aggressive grass weed (*Paspalum* spp.), which in the 1950's led to the disappearance of the predominant orientation of local agriculture at that time. None of the farming system types were capable of overcoming this crisis, in the sense implied by the concept of sustainability: rebouncing to the original state of the farming system after a period of adjustment to the stimuli. Rather, all types of farming systems were forced to modify their structures, functioning and orientations, in order to be able to live with the new weed situation. Another example of this kind of inability to maintain the system's sustainability in the face of a physical-biological crisis, is the consistent pattern of decreasing average yields due to the depletion of the soil's natural fertility levels.

2. New technological alternatives were designed to improve the results of the main crops. However, given the very strong constraints in terms of capital and land availability, the aim of the program, rather than having a productivity and profitability bias, was to generate innovations which could: (a) strengthen the autonomy of the house-hold economy, by reducing its very high dependence (75% of total income on government poverty subsidies and seasonal off-farm labor; (b) strengthen the sustainability of the farming system, in terms of recuperating lost crop diversity and better-balanced crop rotations, as a way to cope with the severe soil fertility and weed problems; (c) strengthen the stability of agricultural

results, in terms of avoiding total crop losses due to drought and frost (once every two years).

After four years it was documented that this approach effectively led to a better balanced family budget (income from external sources now accounts for less than half of the total), to a more diversified crop structure and improved indicators of soil fertility, to the effective control of weed problems, and to 100% avoidance of total crop losses. It also led to an increase in the average value of such assets as agricultural tools and machines. However, net monetary income did not increase. In this case of non-participant families, the status of the above-mentioned indicators was exactly the opposite.

CONCLUSIONS

1. The relationship between sustainability and productivity, profitability and, in general, farming system viability, is complex. It depends on the type of farming system, and, in particular, on the availability of land and other resources. Also, it depends on the specific type of stimuli which confront the farming systems.

2. An FSR/E approach which strongly considers the concepts of sustainability, stability and autonomy, can expect to have reasonable positive impacts, in terms of agricultural and overall economic improvement. However, under certain circumstances, it may be at a disadvantage (with respect to programs that stress the concept of productivity) in terms of improving net monetary income.

3. Therefore, the place of the concept of sustainability within a FSR/E project, must depend on the circumstances (types of farming systems and kinds of stimuli which can be expected) and on the goals that are being sought.

60 > FARMING SYSTEMS AND ADOPTION OF NEW TECHNOLOGIES: NEW SORGHUM CULTIVARS AND SOIL CONSERVATION STRUCTURES IN SOUTHERN HONDURAS

Miguel A. Lopez-Pereira, John H. Sanders, Dan H. Meckenstock

The Honduran Ministry of Natural Resources (MNR) and other government and international agencies, have tried for several years to solve the problem of low productivity and poverty of the small farmers in the country. More recently, these agencies have been concerned with the depletion of the forest land due to the expansion of crop and cattle operations; and the traditional, soil destructive slash-and-burn agricultural systems practiced by the small farmers living on the hillsides of the south. This system is causing sever, and possibly irreversible, damage to the river watersheds if not stopped soon. Emphasis has been placed on yield and productivity enhancement of small producers of basic cereal grains, especially maize and sorghum. As well, there has been a stress on the introduction of soil conservation techniques for the hillside landholdings owned by small farmers. This effort has concentrated in southern Honduras, where most of the farmers are small and face very harsh environmental conditions.

However, the level of adoption of these technologies, which have been available for several years, has not been measured. Moreover, it is not known what the impact of these technologies has been on the small farmers' income or on the structure and fertility of their fragile, erosion-prone landholdings. Informal analysis and on-site experience reveal that the level of adoption of the technologies appears to be very low. One of the possible reasons for this may be the lack of a complete and realistic knowledge of the small farmer's environment and how this environment affects his adoption decision. Another factor may be the natural attitude of small, capital constrained farmers to avoid risky situations. Although they may have the potential to increase cereal yields significantly, the new technologies may also be perceived to be too risky by the farmers in the region. Thus they show a reluctance to adopt them and prefer to continue their traditional, though inefficient and destructive, agricultural practices.

This study explores the results of an economic survey done in November and December of 1988 in southern Honduras. Thirty six of a sample of 119 farmers interviewed were analyzed here; 18 farmers assisted by the extension program of MNR and 18 non-assisted were included. Issues related to adoption of the new agricultural technologies developed during the last six years for the small farmers in the south were discussed in the surveys. The technologies included the improved sorghum cultivars Sureno, Catracho, and Tortillero, developed by INTSORMIL/MNR; and structures for soil conservation such as stone walls, ditches, terraces, and live barriers introduced by the Watershed Management Project sponsored by the U.S. Agency. The subjective attitude of the farmers towards risk and its effect on adoption were also analyzed. A profile of a farmer and characteristics of his farm which is more likely to adopt the new technologies was developed.

Results indicate that the new sorghum "Sureno" shows the highest adoption level. The cultivars "Catracho" and "Tortillero" had very low levels of adoption although they were released before Sureno. The most popular soil conservation structures among the small farmers of the south are stone walls and ditches to prevent erosion and to retain humidity. Farmers who are assisted by MNR had a much higher level of adoption than non-assisted farmers. Adoption of the technologies considered here appears to be part of a larger technological package being adopted by the farmers. Most of those who have adopted the sorghum cultivars, also use crop rotations, organic fertilizers, and have eliminated the slash-and-burn systems of land clearing and preparation in their fields. The adoption of these innovations was much higher among those who have adopted the improved sorghum and soil conservation techniques than among those who have note adopted them. Attitudes toward risk did not appear to have any impact on the level of adoption. Both adopter and non-adopter groups showed similar risk aversion characteristics; most of them were very risk averse without regard of their status as adopters or non-adopters.

Farmers who have adopted the new technologies are younger, with a significantly higher level of education, smaller landholdings, larger family size, and lower off-farm income than the non-adopters of the innovations. As well, most adopters were assisted farmers. Farms of adopters farmers were mostly hillside landholdings, with maize, sorghum, and field beans as the most common crops grown. The adopters were located on average about three miles from the nearest extension office.

61 > TECHNOLOGY GENERATION AND DIFFUSION UNDER UNCERTAINTY: A MEXICAN CASE STUDY

Robin Marsh, Sandra Archibald

Technologies that require purchased inputs often increase agronomic and economic risk to small-scale producers, particularly for farmers on rainfed lands who typically face a complex array of risk factors that influence their technology adoption decisions. In addition to agronomic, climatic and pest variability that make production stochastic, producers in developing countries are subject to unequal access to labor, credit, markets and information, affecting transaction costs and net returns. These risks can be minimized if technology and factor-use recommendations are appropriate to on-farm conditions, effective extension is available, and the input/output price ratio is favorable. Producers' adoption of a recommended technology remains dependent, however, upon expected net returns and their variability as well as each producers' ability to "bear" the risks of adoption. Consequently, an understanding of risk and risk behavior is critical to the success of technology generation and diffusion, credit and other policies directed toward small-scale producers.

In this paper we explore the relationship between low adoption rates among small-scale Mexican maize producers and the treatment of risk by alternative technology generation and diffusion programs. We compare optimal economic fertilizer use derived

from neo-classical theory with allocative efficiency when a measurement for risk is incorporated. Rick is treated as a composite of uncertain production and "risk averse" behavior. The degree of risk aversion reflects differences in socioeconomic endowments and institutional affiliations among farm households. The contribution of these factors to risk aversion is determined econometrically.

Once the principal explanations of risk averse behavior are identified, the net benefits from fertilization adoption are compared for producers exhibiting high and low levels of risk aversion, and the effectiveness of alternative programs in capturing risk is assessed.

Models of technology generation and diffusion programs with different treatments of risk, summarized in Table 1, include: (1) Traditional programs which derive optimal factor-use recommendations by maximizing net returns from new technologies tested under experiment station conditions. Such programs fail to consider capital constraints, farm-specific agronomic variability, yield variability and risk attitudes of producers. (2) "Modified" traditional programs recognize capital constraints faced by producers and technology generation is tailored to specific "agro-systems". However, optimal technology generation lacks yield and price variability analysis and an understanding of the differential ability of producers to bear risk. (3) The farming systems research and extension model treats risk most thoroughly. Technology is derived from results of on-farm, farmer-managed experiments and is limited to homogeneous micro-agrosystems or "recommendation domains". Optimal factor-use recommendations incorporate risk by considering yield and price variability under a minimum returns and sensitivity analysis framework. Implications of technical change for long-term resource sustainability are also considered. FSR/E emphasizes intensive multi-disciplinary extension and understanding of inter- and intra- community differences in producer endowments and risk averse behavior.

Data for the crop year 1985 were collected from 155 randomly selected small farm households in the Lake Patzcuaro region of Michoacan, Mexico. Half of the sample producers are covered by Consultores del Campo, a farming systems research and extension program working in the region since 1979. The other half are covered by government directed technical assistance and credit programs (SARH) that fit closely to the modified traditional model described in Table 1. In the study year, a subset of these households participated in PIPMA, a special national program for increasing maize productivity on small farms in high-potential areas.

Results from the econometric analysis show that the discrepancy between recommended fertilization under profit maximization without risk and actual producer practices is a function of risk associated with agronomic variability and risk averse behavior. By relating risk aversion to household socioeconomic characteristics and institutional affiliations, it was possible to identify the constraints that explain producers' risk aversion to the adoption of new technologies. Results indicate that socioeconomic factors that diminish the producer's ability to bear risk can be overcome, in part, when poorly-endowed households are provided access to appropriate technology, technical assistance and credit.

Programs which reduce risk aversion to the adoption or recommended technologies do not necessarily improve the welfare of participants, and may achieve the opposite effect. To be effective at both reducing risk averse behavior and improving producer welfare, technology generation and diffusion programs must: (1) recognize the high degree of agronomic heterogeneity among small-scale rainfed farms; (2) incorporate production risk and risk attitudes in the generation of recommendations directed toward small-scale producers; (3) provide credit to cover the variable costs associated with technology adoption, and adequate indemnification for losses incurred by insured producers; and (4) provide effective institutional support, especially field level farmer-to-farmer extension. The farming systems model comes closest to meeting these criteria and to achieving allocative efficiency under risk.

THE ROLE OF FSR/E IN SUSTAINING RESOURCE-POOR FARMER PARTICIPATION IN AGRICULTURAL RESEARCH AND DEVELOPMENT: A CASE STUDY FROM SOUTHERN BRAZIL <62

W.J. Sorrenson, R. de Nadal, N.L. Dalmazo, J.B. Dent

In April 1986 the GTZ (Deutsche Gesellschaft Fur Technische Zusammenarbeit) commenced a FSR/E project in the western region of the State of Santa Catarina (SC) at the request of the State Government Agricultural Research (EMPASC) and Agricultural Extension (ACARESC) Organizations. The project was installed at the State Research Center for Small Farmers (CPPP) of the EMPASC and administered jointly by the EMPASC and ACARESC in cooperation with the GTZ. Initially the project was implemented within the Socio-Economic Program of the EMPASC and the Farm Management Program of the ACARESC involving a full-time team of seven plus a farming systems expert, and a further four researchers part-time (1 soil scientist, 1 agronomist, 1 sociologist and 1 statistician). Other researchers and extensionists were indirectly involved. In August 1988 the ACARESC withdrew formally from the project for "institutional" reasons and EMPASC continued in cooperation with the GTZ.

The case study region is in a subtropical zone with an annual rainfall of approximately 1800mm well distributed. Originally the farmers of Italian and German descent commenced some 50 years ago. Colonization was rapid and today less than 10% of the area is still in native forest. Soils are variable but primarily of basaltic origin naturally fertile. Topography is generally steep and the soils stony. The summers are hot and the winters cool. Frosts are common in most areas and droughts can occur at any time. Many microclimates are prevalent in the region.

Farming systems have evolved over the years. They are characterized by intensive cropping using animal traction in labor intensive operations. Lack of crop rotations, zero or little use of fertilizer and agro-chemicals, little soil conservation and consequential staggering soil erosion. Maize is the predominant crop being transformed into chickens and pork. Blackbeans and soybeans are grown commonly intercropped with maize. Small farmers have evolved very sophisticated systems of production to reduce costs and minimize risks. High rates of inflation (which can exceed 1000% per year), widely fluctuating product and input prices (in real terms), commonly occurring droughts and frosts, and unfavorable and changing agricultural policies, all add up to a high risk environment farmers face.

A recent statistical classification of farms based on farm census data delineated 7 main farm classes. In 4 classes pig production was the predominant activity and in the other 3 cereal production was the main activity. Eighty five percent of all small farms in the region were grouped into these 7 farm classes.

The region totals 2.3 million hectares (31% of the state of Santa Catarina) with approximately 90,000 small farms (94% of all farms) and produces 60% of the total value of farm production of the state. Farm earnings are extremely low (averaging less than $250 per annum per equivalent adult family member even when no return on the farmer's capital is allowed for) despite the fact that on average farmers sell around 80% of their total production, the rest being used for family consumption. Farmers react typically as subsistence farmers. Farm decisions are made on the basis of experience. No data are recorded by farmers.

The region is developing extremely fast, based primarily on privately owned agro-industries processing pigs and chickens. Farmer cooperatives are established but resource-poor farmer participation in their running has not evolved to date. Resource-poor farmer and farm worker organizations are commencing but their political power is as yet untested.

The EMPASC is organized in 22 programs primarily commodity oriented. The ACARESC is organized also by commodity or subject programs in a top-heavy centralized structure. Both organizations use the traditional approach where-by the farm is not viewed as a

whole system with the farmer as the focal point. The farmer, his objectives, systems of production and problems as conceived by him have been essentially ignored. A FSR/S approach is being introduced into the EMPASC as a result of this project. The ACARESC is commencing a whole-farm farm management program but its affect so far has been negligible. Typically research and extension programs in Santa Catarina have been formulated without any participation of resource-poor farmers.

A recent random survey of farmers in the region researched farmers objectives and their attitudes towards the technologies being offered by research and extension. Farmers confirm their willingness to expand production and to collaborate with researchers to identify and test appropriate technologies. Their main reasons for not adopting the alternative technologies being offered to them is because in their opinion they are too costly and risky. For example, many sighted their experiences of borrowing credit from the bank to buy fertilizer only to be faced later with crop failure due to drought and a loan still to be paid.

A FSR/E approach was taken in the project. This involved training key personnel at CIAT and IRRI and later installing field teams of 2 or 3 researchers and extensionists to start on-farm research beginning with rapid rural appraisals and then installing some experiments on farms of collaborating farmers depending on the farmers conceived problems and his agreement to test possible technical solutions. This immediately had the effect of bringing the researcher together with the extensionist to the level of the farmer for the very first time in the region. At the same time complementary activities were initiated to orient the on-farm work: the farm classification and farmer attitude survey already mentioned; a computerized farm management analysis system; then later a multiple visit farm management survey of a number of typical farms; computer models of the main farm activities and whole-farm models of the main farm types were initiated. At all stages of the project farmers were fully consulted and their participation where possible encouraged in an attempt to:

(1) understand their problems, not just technical but also socio-economic;
(2) understand their farming systems and to help determine bottlenecks to increasing production and profitability;
(3) to involve farmer groups and organizations to increase farmer participation;
(4) on-farm trials were only installed with the approval of the farmer and his participation in all possible stages encouraged.

The project has resulted in the introduction of FSR/E in the EMPASC. Unfortunately ACARESC are no longer formally involved. However, at the local level extensionists of the ACARESC are participating and extensionists of the farmer cooperatives are formally involved, as are representatives of the small farmer organizations.

The process of effectively involving farmers in a bottom-up technical design/adaptation process has been shown to be slow, but the chances for effective farmer participation are so encouraging that the work will continue.

A problem we are confronting is how best to institutionalize FSR/E? The approach taken so far has been to incorporated the concepts slowly minimizing in the first instance formal institutional changes. The method of initiating the process n a socio-economic farm management program of a research service and mounting inter-disciplinary teams of researchers including extensionists, has worked well. An important element in the process has been training a few (in our case four) key personnel in short farming systems courses. We are now able to train other personnel ourselves. Another very important aspect has been adapting FSR/E methodologies to the real situation that exists in our region. But where best to go from here?

It is now being generally accepted in the region, that to sustain production and profitability of the resource-poor farmers, some major changes need to be made to the existing farming systems. In other words, there is a clear need for "New Farming Systems Development". There will need to be developed cropping rotations, soil conservation measures, agro-forestry, integrated pastoral cropping systems, etc. There is no doubt FSR/E has an important role to play. There will be a need to use models in this process, both mathematical and physical, to assist in the identification of feasible alternative systems. An effective participation of farmers will be essential to this process.

63 > HUMAN ADAPTATIONS TO HIGH RISK ENVIRONMENTS: CAMELLONES "WARU-WARU." TRADITIONAL AGRICULTURAL TECHNOLOGY OF THE PERUVIAN ANDES

Mario Tapia, Mariano Banegas

In the high plateau of Puno, Peru at 3,800 m their is a great variation in participation and temperature. Flooding is common and it has pronounced affects on the natural vegetation and agricultural crops. Frost is also common during and after the growing season. This effects food production and the peasant economy in general.

These two environmental conditions can occur periodically without warning and cause dramatic agricultural losses. Environmental uncertainty is probably one of the major factors that contributed to the evolution of raised field agriculture in the high Andes, more than 1000 years ago.

Raised fields are integrated systems of land management that allow for many simultaneous benefits. The fields were usually safe from flooding and the water that fills the channels between the fields acts as a thermal mass that absorbs and holds solar energy into the night. The heat radiated from the water at night helps to reduce the effects of low nocturnal temperatures.

These raised fields were called "waru-waru" and their construction required much human labor to transform flat areas into a series of ridges, usually of a rectangular shape about one meter high. These flat raised beds were then surrounded by water channels.

The first archaeological work on these fields was conducted by Clark Erickson in 1980-1983. His work has been followed by Ignacio Garay Coches who has worked with several peasant families. As a result of this work their has grown a wide spread community based interest in the re-building and utilization of these raised field.

In 1986, INIA, the agriculture research institution of Peru, built a two hectare experimental area at the Illpa research station, near Puno, Peru. As part of the project experiments were designed to evaluate the micro-thermal effects and crop rotation systems of these camellones.

Results show that high crop yields are in general obtained. The production is however dependant upon the scale of camellones constructed. In order to achieve the desired micro climatic beneficial effect, no less than 30 m radius of camellones and channels. This will reduce in a significant way the effect of a mild frost if the water channels have a minimum water level. This data indicates that the camellones were likely to be part of a larger system intended to collect water from the rivers and/or from well as the flood waters caused by the increased water level in Lake Titicaca. Crop rotation experiments in the camellones show that inclusion of a forage legume could provide enough food to maintain a large number of animals that could return manure enough to maintain the soil fertility.

As a conclusion it can be said that this ancient agricultural technology should be included in the modern agricultural system of the area. Its utilization should be integrated with new agricultural advances so that the most productive elements of old and new technology can be combined to maximize food security in this region of Andean Peru.

SUSTAINABILITY OF AGROFORESTRY AND AGRICULTURAL SYSTEMS USED BY RUBBER TAPPERS AND SETTLERS IN THE STATE OF ACRE, BRAZILIAN AMAZON <64

Juson F. Valentim, J. Aramis, D. Cordeiro, Marianne Schmink

In 1986, the Federal University of Acre (UFAC) and the University of Florida (UF) began a program of technical cooperation focusing on ecological, social and economic aspects of agroforestry and agricultural systems used by rubber tapper and settlers in the state of Acre, in the Brazilian Amazon. The program is aimed at strengthening the technical capacity of UF, UFAC and other local institutions to develop, through the methodology of farming systems research and extension (FSR/E), multidisciplinary and inter-institutional activities that will help in formulation sustainable policies for agroforestry and agricultural development, with reduced environmental impact and emphasizing the rational use and conservation of natural resources. The main objectives of this program are: 1) identification of factors limiting the sustainability of agroforestry and agricultural systems used by rubber tappers and settlers and 2) planning and carrying out multidisciplinary and interinstitutional research and extension activities that contribute to the development of sustainable agroforestry and agricultural systems.

The FSR/E methodology used was adapted from previous experiences in different tropical regions and from agroforestry techniques. The diagnostic study involved a continual process of interviews and discussions among specialists of different areas and the client populations, both agriculturalists and rubber tappers. A sondeo was conducted in June of 1988 by 34 specialists in the following areas: agronomy, soils, forestry, biology, economics, sociology, anthropology, statistics, and chemistry. They represented 13 institutions including universities (UFAC and UF); NGOs (CIMI and CTA); Acre state agencies (CEPA, FUNTAC, IMAC, SDA); and local branches of federal or regional agencies (EMATER, EMBRAPA, IBDF, INPA, MIRAD). The participating institutions have mandates in the following areas: teaching, research, extension, agricultural settlement, community development, environmental protection and Indian affairs. The client population for the research consisted of settlers in the agricultural colonization projects "Pedro Peixoto" and "Humaita" and rubber tappers of the "Seringal Triunfo" and "Seringal Pi-ra-de-ra". During the survey 51 settlers and 13 rubber tappers were interviewed. The information gathered was evaluated and analyzed to identify factors limiting the sustainability of the agroforestry and agricultural systems practiced by rubber tappers and settlers.

Interviews with settlers showed that planning and implementation of the colonization projects was carried out without previous knowledge of the potential of the natural resources in the target areas. This led to deforestation of areas rich in Brazil-nut trees and rubber trees, with low soil fertility and poor water resources, for agricultural purposes. Also, the majority of the settlers came from other regions of Brazil and lacked knowledge of the potential of the natural resources. The inadequate utilization and management of these resources results, in general, in environmental degradation and, once these resources are exhausted, in migration of the small farmers in search of new forest areas or to the urban areas, where they live in slums (*favelas*).

Analysis of the information gathered from the rubber tappers showed that the extraction of rubber and collection of Brazil-nut are sustainable processes of exploitation of the forest with reduced environmental impact. However, the lack of transportation, credit, an organized marketing structure for these products and legal ownership of the land, associated with the poor quality of public health and education services, have, in many cases, undermined these extractive systems. Also, the growing political and demographic pressures for the occupatio of these forest areas with agricultural livestock projects result in eviction of the rubber tappers, who usually migrate to urban areas, contributing to the growth of the slums.

The FSR/E methodology used in the research revealed the lack of cooperation among local institutions as one of the main factor limiting the capacity to develop a process of planning rational policies for agricultural and agroforestry development in the State of Acre. The results of this multidisciplinary and inter-institutional research indicate, not only the potential for strengthening the institutions, but also the possibility to intensify the cooperative actions of these teams in search of sustainable agroforestry and agricultural systems adapted to the soil and climatic condition of Acre. These cooperative actions include: a) study of sustainable agroforestry and agricultural systems aimed at recovering degraded areas; b) development of rational methods of utilization and management of natural resources; c) study of methods of pest and disease control for the main annual, perennial and horticultural crops in the field and during storage; d) study of the economic potential of native plants and animals; e) development of mechanisms aimed at strengthening rural communities; f) adaptation of education techniques and schoolcalendars according to the activities of small farmers and rubber tappers; and g) recuperation and study of the culture of rubber tappers.

FSR/E: A CASE STUDY FROM ARGENTINA <65

Hector Varela, Douglas Pletsch

INTRODUCTION

Productive agricultural research and extension systems are crucial to the improvement and development of agricultural economics. At the time this study was conducted, the government agency in Argentina concerned with the development of research and extension programs was INTA (Instituto Nacioal de Tecnologia Agropecuaria). It is a federally administered, independent agency of the Federal Secretarist of Agriculture.

INTA was organized in 1956 around national programs of research and extension, with disciplinary focus. The dissatisfaction of the INTA directors with the results of this conventional approach led to the search for alternatives. The Farming Systems Research (FSR) and On Farm Research (OFR) offered a useful contribution to new concepts and methodologies had the potentiality to solve many of the problems that existed in the development of traditional technology, reinforcing the linkages among farmers, researchers, and extensionists; and emphasizing the research under farm conditions.

NUZEAs' CREATION IN INTA (ARGENTINA)

IN 1985 the directors of INTA decided on the creation of four Experimentation Adaptive Teams (NUZEAs: Nuclios Nonales de Experimentacion Adaptative) in different provinces of the country. The philosophy and creation of the NUZEA teams, and its function in INTA were closer to the FSR approach to research. Some of the common characteristics of the FSR approach and the NUZEAs in INTA were: (1) holistic applied and empirical problem solving approach to research; (2) holistic framework; (3) an interdisciplinary team approach; (4) concern with downstream research and feedback to upstream research activities; (5) farmer participation and (7) the use of recommendation domains to the diffusion of the adapted technologies among groups of farmers with similar characteristics. These are recognized as characteristics of the FSR approach by several authors (CIMMYT, 1980; Lageman, 1982; Simmonda, 1985; Biggs, 1985; Maxwell, 1986; Johnson, 1986; Jones, 1986; Merrill-Sands, 1986; Pembarton, 1987).

PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of this paper was to report and to analyze the recent experience of INTA with the insertion of FSR teams in to its tradi-

tional research-extension structure. The literature reviewed was unanimous in recognizing the need to link the extension service with the FSR approach for obtaining more efficient and acceptable agricultural technologies (Shaner, 1982; CIMMYT, 1987; Rhoades, 1987; Arnold, 1987; Jognson, 1986; Gilbert et al, 1980; York, 1987; Norman and Collinson, 1985; Simmonds, 1986; Winkelman, 1983; Moris, 1983; Wooley and Pacheco, 1987). Nevertheless, the difference between these theoretical proposals and the actual situation was evident (Fresco, 1987; Swindale, 1987; Chigaru, 1987; Coulter, 1983; Andrew, 1987; Tarte, 1983; Dag, 1983; Byarles, 1987; Dorward, 1986; Espinosa and Garret, 1988).

As a result it appeared necessary to address and explore the institutionalization of extension into FSR in INTA. Consequently, the purpose of this study was to determine the function of the extension service on the new scheme adopted by INTA, and to determine in which ways cooperation between services could take place to increase efficient and effective technology transfer or diffusion of new ideas. The objectives of the study included: (1) to document the development and function of FSR (NUZEAs) and extension in INTA; (2) to determine the degree of integration between FSR-extension in INTA after the insertion of FSR teams into its traditional structure; and (3) to analyze the constraints to a more complete integration as perceived by extensionists and by researchers.

METHODOLOGY

The subjects in focus for this study were the NUZEAs located in Venado Tuerto, Province of Santa Fe, in 9 de Julio, Province of Buenos Aires, Argentina, and the rural extension agencies of these areas

Both primary and secondary sources were used in this research. Primary data was collected by mailed questionnaires went to extensionists and to NUZEA team members. The sample involved 100 percent of the professional staff referred to in the study. It was a small, but purposeful sample which was selected for the richness of information that it could provide. The percentage of return was very high (86 percent). As well, a case report of the first two years (1986 and 1987) of implementation of the NUZEA South of Santa Fe, based on personal observations and participation of the author, was included as part of the primary data. The secondary sources consist of the review of institutional report, project documents, letters and bulletins as general background material.

This study followed a qualitative approach to data collection. As well the qualitative approach proved most appropriate in the data analysis.

FINDINGS, DISCUSSION, AND CONCLUSIONS

Preliminary findings from this study suggest a lack of integration and coordination between the NUZEA teams and the extension services. The unclear definitions of roles, the lack of participation of extension in program planning and the overlapping of activities of the both group, appear to be some of the barriers to major involvement of extension personnel in the activities of the NUZEA teams.

REGIONAL SESSION: UNITED STATES

WORKING TOWARD LOW-INPUT SUSTAINABLE FARMING SYSTEMS IN THE PALOUSE REGION OF EASTERN WASHINGTON AND NORTHERN IDAHO <66

Curtis E. Beus, John Carlson

The Palouse region of Eastern Washington State and Northwestern Idaho has some of the most severe soil erosion problems in the United States. The region also has the highest dryland wheat yields in the nation. The depth and quality of the Palouse loess soils has been very "forgiving" and allowed many farmers disregard soil erosion practices, and to utilize extremely high levels of chemical inputs to obtain the maximum yields possible in the area. Interviews were conducted during the Spring and Summer of 1989 with thirty Palouse region farmers. The farmers interviewed were identified as those who were utilizing "low-input sustainable" farming practices. The interviews were conducted in a semi-structured, open-ended format in order to elicit as much information specific to each farmer's operation as possible. Questions were asked in a wide variety of areas. Some of the major findings included: (1) government farm programs are poorly redesigned for Palouse farmers and cause them to discontinue crop rotations and other sustainable practices, (2) the only farmers who had been utilizing green manure crops in their rotations over an extended period were required to do so in their leases, (3) very little information is available to Palouse farmers who want to reduce inputs while maintaining adequate soil erosion practices, (4) a major "benefit of adopting low-input sustainable farming systems is the enjoyment and satisfaction gained by farmers who feel they are doing something good for the land, and leaving it in as good a shape as possible for the next generation, (5) many farmers were identified who had drastically reduced their input levels while maintaining their yields, (6) many farmers indicated that the biggest obstacle to adopting a low-input system is in the minds of the farmers themselves, (7) the land-grant university system has perpetuated the belief among farmers that the only way to farm in the Palouse is through high levels of inputs and seeking maximal yields, and 98) according to many farmers, decreasing input levels of fertilizers and chemicals seemed to improve soil tilth and workability, reduce soil erosion, and decrease incidence of plant diseases and major weed problems. Farming systems research and extension has long been utilized in developing nations to improve agriculture. Agriculture as practiced in the Palouse region of Eastern Washington and Northern Idaho, as with most of the rest of the United States has developed under the direction of narrowly defined, reductionistic approaches to agriculture. Although this has greatly improved the short-run productivity of U.S. agriculture, it is jeopardizing the long-run viability of the U.S. agricultural industry, especially in areas like Palouse. Our research indicates that there is a great need for an interdisciplinary approach to address the problems of "overdeveloped" agricultural systems such as those in the Palouse. Further application of reductionistic agricultural development in the Palouse will surely destroy one of the most fertile farming regions in the United States.

INCREASING SMALL FARM PRODUCTIVITY THROUGH ON-FARM RESEARCH INTERVENTIONS <67

Udai Bishnoi, Petros Mtshali, Cathy Sabota

With the exception of Europe, the U.S. and Australia, small farms contribute the majority of agricultural production in almost all countries. In the U.S., the percentage of the total agricultural production attributable to small farmers contribution depends on the particular commodity. For some commodities, the small farmer contribution is significant. However, applied or on-farm research to improve production efficiency of these small and often limited-resource farms has been overlooked. In 1985 three small farms in Alabama were selected for replicated on-farm research to increase production and income through multiple cropping or by adapting new production techniques. On one small vegetable farm, early tomatoes were planted in and under plastic and were followed by a fall cabbage crop. Use of black plastic mulch increased earliness of marketable tomatoes by one week, while mulched plants yielded 26% more than non-mulched tomatoes. Cabbage planted after tomatoes produced significantly higher yields with a split application of N versus the entire amount applied at planting. The head weight and count were 30% higher for split-applied versus single-applied versus single-application nitrogen treatments by the farmer. Split-applied nitrogen for both crops produced 21 to 33% higher yields compared to the farmer's rate and method of application. Other on-farm research was conducted to determine the effects of row spacing and phosphorus rates on soybeans produced on a limited resource farm. Results showed that soybeans yielded 32% higher in 45 cm row spacing with 23 kg P_2O_5/ha than the traditional row width with 68 kg K_2O_5/ha.

STRENGTHENING EXTENSION THROUGH THE CONCEPTS OF FSRE AND SUSTAINABILITY <68

Lorna Michael Butler, Jack Waud

Introduction

Land grant universities, including Extension, are under increasing pressure to regain their relevance to society. Numerous studies and papers have attested to the need for institutional re-structuring and revision of program priorities. Schuh (1986) expresses concern that land grant institutions must strengthen their abilities to solve the critical problems of society. Feller (1987) notes Extension's inability to maintain credibility with traditional clientele, and as a result, they are going elsewhere for the information they need. It is increasingly difficult to justify the linkages between researchers, specialists and agents in a research - based technology transfer system.

Supportive agriculture research has been a limiting factor for several decades. Extension programming has evolved beyond the traditional agriculturally - based research. Extension has lost its original commitment to client - tested research, and the ability to efficiently maintain and adapt needed competencies of staff.

The focus of LGU programs has traditionally been production agriculture, rather than the entire food chain. Industry and society concerns imply the need for an integrated perspective in which the interests of all involved in the food system (farm and farm household, community, consumer, processor, wholesaler, retailer) must be a part of Extension and research programming.

The Extension system must become much more responsive to "the compelling issues facing people" (ECOP Futures Task Force, 1987). One of these critical issues concerns the need for a profitable and responsive food system, and one that is protective of human health and environment. This paper will direct attention to ways in which Extension could rise to this challenge to give leadership to a critical national issue; at the same time, address needed institutional changes for the benefit of the total LGU. Primary attention will be given to the Washington State University - Oregon State University Low-Input Sustainable Agriculture Program initiated in 1988 through USDA - LISA funds. The project title is: "Evaluation and Design of Low-Input Vegetable/Small Grain and Small Fruit Systems of Western Oregon and Washington."

Ways FSRE Approach Can Strengthen Extension

The WSU-OSU program is drawing on some of the central concepts and skills associated with the FSRE approach, including "lessons learned" from its application in the Third World. Central to the program is the recognition that public perception is powerful force, driving consumer acceptance, special interest groups, markets, and political support.

The project is designed around an integrated systems approach,

development and use of interdisciplinary teams, increased levels of producer and producer household involvement, and early Extension - research - producer linkages. These elements of FSRE are recognized in its infancy. The presenters have made some observations concerning the long term institutional applicability of these elements.

The WSU - OSU Low - Input Sustainable Agriculture Program

The paper will include a description of the program setting, principle program objectives and underlying assumptions. For example one basic assumption of the program is:

Innovative or "research - minded" producers, and members of their households, are valuable sources of knowledge for identifying and disseminating LISA practices.

The presentation will describe and analyze primary program setting, principle program objectives and underlying assumptions. For example one basic assumption of the program is:

Innovative or "research - minded" producers, and member of their households, are valuable sources of knowledge for identifying and disseminating LISA practices.

The presentation will describe and analyze primary program strategies and activities. Examples are: a rapid reconnaissance survey of a fresh produce marketing system; a researcher/producer/consumer/Extension symposium; and a set of whole farm/farm household case studies on innovative Western Washington and Oregon vegetable and small fruit production systems. Emphasis will be on preliminary institutional insights regarding such issues as: producer/producer household involvement in applied research and technology transfer, research - Extension collaboration, faculty orientation and re-training, faculty motivation and incentives, funding and resource enhancement. conclusions will address how "lessons learned" might be applied to institutional changes in Extension.

69> THE CASH SYSTEM OF ON-FARM DECISION TOOLS FOR OPTIMIZING CROP MANAGEMENT

Franklin R. Hall, James R. Lemon

Empirical practices such as pest control are practiced only as a means of furthering the purposes of production systems (Geir and Clark, 1978/1979) and, as such, they sometimes must be initiated under emergency conditions with less than perfect knowledge of the actual status of the pest/injury relationships within the system. Gruys (1982) notes that the slow adoption of integrated pest management (IPM) in practice is a general phenomenon in agriculture. Additionally, Poston et al. (1983) stated that few operational pest management programs are truly integrated.

An analysis of successful IPM programs suggests that the following 4 factors are the key to implementation of a new crop protection (or production) strategy within the free enterprise system:

1) Economic benefits are clearly demonstrated.
2) Adequate information/demonstration of program.
3) Has grower interest and positive attitude.
4) Does not increase (envisioned) risk.

Changes in pest control strategies involving pesticide management must have the confidence and active cooperation of the user clientele (Barfield and Stimac 1980). Corbet (1981) presents a elegant review of the complexities involved in making IPM a viable and practical approach to sound plant protection. Additionally, if new crop protection strategies are to be fully implemented, certain baselines of current crop protection expenditures and fruit losses must be identified. These appear to be legitimate requirements for the implementation of a pesticidal strategy that is meaningful to orchard operations and that will be a continuation of the economic and ecological advances already make in the use of pesticides in fruit production (Hall 1977). In view of the wide range of use rates reported (Hall 1983), this will require increase interdisciplinary cooperation by Research and Extension scientists.

Farmers' attitudes towards pest or disease control are not implicit in recommendations, and decision-making requires explicit choices. This is very important as it may change the tendency to incorporate farmers attitudes in integrated pest and disease control systems. Forecasts of pest and disease severities are used to determine the expected yield expectation, timing of the pathogen or pest in the growing season and environmental conditions. Presumable, a knowledge base of rules and associations related to horticultural crop management could be designed to provide the expert support needed by horticulturalists operating in isolated environments. Such a system of decision support, in theory, would apply to all aspects of horticultural crop production.

There is a clear need to clearly identify the scale of risk and also the costs needed for various control measures. To do this , simulation models incorporating such effects may help to quantify the consequences of various tactics. these simulation models help to make an explicit choice from risk-seaking or risk-averse behavior; they replace "gut feelings" by "calculated risks." Advice should be field-specific and take into account the history and prospects of the crop, including presence or absence of growth and yield-limiting and reducing factors. Such decision-making requires much field-specific information and information processing.

Simply stated, the CASH system of decision tools is designed to present an alternative view of how information may be better utilized at the farm level. Specifically, the initial tools allow an identification of the key factors which influence net economic return, the extent to which they influence the bottom line and suggests a review of the following concerns (beyond normal accounting) at the enterprise level:

Analysis -	How am I doing?
	What is this worth?
Evaluation -	Where does that put me?
	How do I compare?
	What are my weak areas?
	Where can I deal with risk?
Planning -	What needs adjustment?
	How much can I expect?
	What are my priorities?
	When should I make my move?
	What are my options?

Initial thrusts are for simple but robust management tools, "what if" programs, which as grower expertise grows, new ideas and expanded "what if" programs are incorporated. An important point is that growers already have more information available to them than they are currently utilizing for crop management decisions. The greatest potential for helping growers improve decision making appears to be through payoff matrix and decision tree concepts. Growers can be taught to utilize risk management concepts for decision making in uncertain environments. This will require (1) identification of key factors influencing net return, (2) learning how to manipulate return, and (3) learning how to assess the "objective" probability of key variables of insects and disease and their impact on cash/return.

The Computer Advisory Service for Horticulture (CASH) project was initiated in 1985 upon receipt of a grant from the Kellogg Foundation. This project targets the development of decision support and instructional software for horticultural enterprises. CASH is organized into 3 components, namely: (1) a decision support system (DDS) component assigned to a full time Programmer/Analyst, (2) an expert system (ES) component established to explore applications of artificial intelligence technology, and (3) a computer assisted instruction (CAI) component to develop instructional software related to program areas addressed by the DSS component.

The DSS component of the CASH project seeks to identify and target generic decision making tasks inherent in farm and pest management which apply to various agricultural commodities. Such tasks often can be implemented via sophisticated application of spread-sheet software. The CASH/DSS software attempts to

organize and present the decision making process per generic task in a manner that facilitates grower implementation and analysis of the end result.

The software development philosophy adapted by the CASH project to develop a large and comprehensive management information system but rather to develop a number of flexible decision support tools that may be flexibly applied to individual situations. As a result, such DSS software may operate on a stand-alone basis or be used in combination where common data bases apply.

The first DSS software program developed by the CASH project is titled "MARKET MODEL," which is designed to enable a grower to analyze marketing options, compare various marketing scenarios, and summarize projected revenue from multiple enterprises. MARKET MODEL allows the user to (1) select a given production base, (2) itemize expenses, (3) allocate production and expenses to various market options assigned a given rate of revenue, and (4) view the calculated results. Having created a given marketing scenario, MARKET MODEL then allows the user to compare scenarios having a common set of attributes and summarizes all scenarios applicable to a given farm operation. To date, the MARKET MODEL initiated from a tree fruit application, a user of the program can in theory apply the system to any agricultural product having multiple market options.

The second DSS software program to be developed by the CASH project is titled "ENTERPRISE MODEL." ENTERPRISE MODEL utilizes window manipulation of data similar to MARKET MODEL and incorporates data sets originally used in MARKET MODEL. The ENTERPRISE MODEL functionally enable the user to apply a sensitivity analysis of production pricing and expenses to one another. Data used in the program is presented in a multiple matrix format and the results are presented via both tabular and graphic format.

The third DSS software program targeted for completion in 1989 is titled "PEST CONTROL STRATEGY." Like MARKET MODEL and ENTERPRISE MODEL, PEST CONTROL STRATEGY takes a generic multi-faceted approach to support the influence of various environmental and managerial factors on a multiple pest complex to determine an optimal pest management strategy. Similar to other CASH programs, the PEST CONTROL STRATEGY MODEL will enable commodity specialists or the end user to design and/or modify applications to any comparable situation.

ORCHARD PLANNER is a new computer softer program for on-farm use designed to assist growers in planning new orchard plantings. The model is based upon key questions involving space available, tree size desired, management input (labor and equipment resources) pollinizer requirements, varietal needs, previous site problems (nematodes, soil constraints, frost), grower goals for filling space, optimizing space, and least cost or minimal management (tree training) goals.

Finally, decision software expertise of the CASH project has also been applied to the development of DSS software for the National Agricultural Pesticide Impact Assessment Program (NAPIAP). A prototype program, Pesticide Benefits Analysis [PBA], has been designed and is currently under review for application in pesticide assessment programs, pest resistance scenario analyses, and LISA program evaluations.

The CASH project now has cooperating scientists from Holland, West Germany and England involved in the development of a larger decision support system for agriculture where the impact(s) [cost/benefit] of a changing agricultural system are weighed (assessed) for a more precise decision process.

IMPACTS OF CROP ROTATION ON THE ECONOMICS OF DIVERSIFIED CROPPING SYSTEMS <70

Glen A. Helmers, Hisham El-Osta, Muhammad T. Javed

The economic foundation for diversification in cropping systems rest upon (1) the opportunity to reduce machinery costs because smaller machinery can be used, (2) yield interactions which increase gross returns when rotations provide the diversification, and (3) reduced risk from multiple crops. In this analysis the opportunities for increased net returns to a rotation compared to single grown crops are analyzed where machinery savings and yield interactions are considered simultaneously. The study area is Eastern Nebraska (U.S.).

Advances in machinery selection methodology allow optimum machinery and crops to be simultaneously selected for a wide range of labor situations and farm sizes. In this analysis the positive yield impacts of rotations are also included in the analysis such that net returns (or cost per dollar of output) of alternative single grown crops can be compared to diversified (rotation) systems over a wide-range of farm sizes.

Integer programming is used to optimize the selections. Costs (per dollar of output) are developed for single grown crops as well as rotation systems at various farm sizes and labor situations. Timeliness related to weather provides field time constraints in the machinery selection process. The results are important to the assessment of single vs. diversified cropping systems.

EXTENSION'S PERSPECTIVES ON SUSTAINABLE AGRICULTURE <71

Dixon D. Hubbard

To be sustainable, American Agriculture must become a more environmentally sound, socially acceptable, globally competitive, and consistently profitable system. Policy makers, farmers, processors, distributors, and consumers and all Extension publics should expect the Cooperative Extension System to provide the leadership in catalyzing change to meet these needs.

Sustainable agriculture is grounded in the idea that systems are composed of forces and factors which must balance humanity's needs, wants and capabilities in long and short terms. Likewise, management demanding system which relies on a balance of market response, free enterprise, technology adaptation, and environmental sensitivity to meet the needs and wants of society. *Sustainable agriculture includes marketing, producing, processing,* and distributing products that we currently accept, and many which we can't even envision.

The production components of a sustainable agriculture system must balance nature's contributions with the available array of chemical, biological and other technologies. Likewise, a sustainable agriculture system must be responsive to scientific developments which meet the criteria of sustainability.

Sustainable Agriculture is a concept which can embrace the concepts of organic, regenerative, diversification, and other components of the agriculture system. The application of methods, technologies, strategies and approaches within this concept must be tailored to current and expected sets of local, regional, and global needs and conditions.

SUSTAINING PRODUCTIVITY AND PROFITABILITY THROUGH FARMING SYSTEMS RESEARCH/EXTENSION <72

John Ikerd

U.S. farmers are faced with growing environmental concerns and rising costs of specialization. They are searching for farming systems that are sustainable as well as productive and profitable. Many are motivated by perceived risks that inputs on which they depend today may not be available, may not be effective, or may

cost much more in the future. Such farmers are searching for ways to reduce their dependence on external purchased input while maintaining their productivity and profits through more intensive management of their internal resources.

The current search for sustainable and profitability in the U.S. agriculture is centered on helping farmers develop more effective farming systems with existing technology while searching for more efficient diversified farming alternatives for the future. Diversified farming systems traditionally have utilized crop rotations to control pests, conserve soil and maintain productivity. Integrated cropping and livestock systems have been used to reduce feed costs, recycle waste and stabilize incomes of U.S. farmers.

The hope for success lies in finding ways to combine new technologies such as micro computers and biotechnology with the tried and proven principles of management by objectives and diversification -- balanced farming with new technologies. Such farming systems will be more complex and thus will require more intensive resource management than do higher input, specialized systems. However, synergistic gains from effective integration of diversified farming systems represent the best hope for achieving sustainability with a minimum of government regulation.

The Question of Sustainability

The term sustainable agriculture refers to farming systems that are capable of maintaining their productivity and usefulness indefinitely. Sustainable systems must be resource conserving, environmentally compatible, socially supportive and commercially competitive.

Systems which fail to conserve their resource base eventually lose their ability to produce. Systems which fail to protect their environment eventually destroy their reason for existence. Farming systems which fail to provide food supplies at reasonable costs lose their utility to society. And finally, systems that are not commercially competitive will not generate the profits necessary for economic survival.

In the long run, farming systems must be profitable or they cannot be sustained. Also, systems must be sustainable or they cannot be profitable in the long run. Even in the short run, there is no conflict between sustainability and profitability from the standpoint of society as a whole. When all costs and benefits to society over time are considered, social costs will exceed social benefits only for those systems that are also sustainable.

The potential conflict between sustainability arises only for individual producers in the short run. In the short run, systems that are most profitable for individual farmers may or may not be sustainable. Also, sustainable individual farming systems may not be profitable in the short run.

Rethinking Gains from Specialization

Specialization has been a dominant trend in farming in the U.S. over the past several decades. Specialization has been motivated by the elusive search for profitability through more efficient use of land and labor. Reliance on synthetic chemical fertilizers, pesticides and other purchased inputs have allowed farmers to abandon crop rotations and mixed livestock, cropping systems in favor of more specialized cropping and specialized livestock systems.

The trend toward greater specialization has been a success from the standpoint of production efficiency, at least as measured in terms of the percentage of consumers' incomes spent on food. Profits associated with specialization have been short lived and elusive as with adoption of new technologies in general. But, major concerns are being expressed regarding the sustainability of current specialized, input dependent farming systems.

There are growing indications of declining effectiveness of the technologies which have allowed specialization in farming. Insects are becoming resistant to insecticides. Beneficial insects are killed and new pests replace the old. The same types of problems arise with increased use of herbicides. Pesticide costs continue to rise as effectiveness of pest control declines.

Previously fertile soils have lost organic matter under continuous cropping and increased fertilization is required to maintain yields. Greater use of pesticides and fertilizers have resulted in greater risks to farmers' health and health of their families. These are internal individual cost which have caused many farmers to reassess the costs and benefits of specialized farming systems.

The Key-Cs in Sustainable Farming Systems

Many U.S. farmers are looking to diversified farming systems to answer the questions being raised by rising social and individual costs of specialization farming systems. This paper proposes a set of guiding principles which can be used in developing more sustainable, productive and profitable farming systems. These principles are termed the key-Cs of sustainable farming systems. The key C-words are: Complementarity, Coordination, Correlation, Conservation, and Contribution.

Sustainable farming systems are made up of enterprises, components, and sub-systems which complement or complete each other. The output of one is an input, or replaces an input, of another. The waste from one is a productive factor for another. Together, the components complete energy, nutrient and other resource cycles.

The components of sustainable farming systems must coordinate with respect to their demands on internal resources including land, labor, machinery, and capital requirements. Components which have the same pattern of peaks and valleys in requirements for the same resources do not allow efficient use of the limited internal resource base.

Systems components should be negatively correlated with respect to production, prices, and net returns, if they are to effectively reduce the inherent risks in farming. One of the potential gains from diversification is risk reduction. However, systems components that are highly, positively correlated too little to reduce risks.

Finally, sustainable systems components must conserve the resource base and must contribute to overall farming objectives. These last two Cs may seem obvious. However, system components may be complementary, coordinate, and negatively correlated and still not achieve necessary levels of short run productivity while conserving resources needed to sustain productivity in the long run.

73> EVALUATION OF LIVESTOCK MANURE UTILIZATION IN ALTERNATIVE SUSTAINABLE AGRICULTURAL PRODUCTION SYSTEM

Jim Kliebenstein, Mike Duffy, Vern Pierce

In recent years there has been increased pressure and awareness on developing sustainable agricultural production systems. The focus has been on increased utilization of production systems which are felt to be less damaging to the environment than systems presently used. These systems would lead to an agriculture which would be sustainable long into the future. Risks of potential future adverse impacts could be minimized.

Movement toward a sustainable agriculture can involve impacts across the farm operation. Research to properly evaluate and gain insight into potential adjustment analysis of the farming system is needed. Proposed changes in current agricultural production practices must be carefully evaluated if they are to be adopted and succeed. This paper will be based on system level evaluation of sustainable agricultural production and the associated management implications.

The study will include development of typical Iowa crop/livestock farm production systems using an economic engineering analysis. Information evaluated for these case study farms will include adjustments in crop rotations, labor constraints, manure application strategies, relationship of hog production and ability to support crop nutrient needs, projected farm income levels, and selected government programs. The foundation for the financial budgets used in the analysis will be existing research reports.

Enterprise budgets will then be combined into a linear programming procedure to evaluate the farm system impacts of the sustainable production strategies. Representative Iowa farms discussed above will be analyzed. Linear programming can be used to quite effectively and efficiently evaluate these alternative case study scenarios.

While the analysis of the case study farms will focus on the feasibility of effective and efficient manure utilization alternatives, the implications of the low-input systems on farm income and government program participation will also be addressed. Research of this scope is needed to provide information for efficient farming system decisions. It provides baseline information for alternative agricultural production systems. Results will cultivate specific management recommendations for low-input sustainable agricultural production systems.

FSR AND FORESTRY: PLANS FOR ACTIVELY USING WOODLANDS IN COMMERCIAL FARM OPERATIONS <74

Steven Kraft, Paul Roth, Thomas Purcell, John Nelson

Survey data from a sample of 264 farm operations was used to assess the extent to which farm operators with woodlands were engaged in the active, commercial management of those lands. The data revealed that most only a very limited number were so involved. The data revealed that most farm operators were interested in the noncommercial use of their land. Regression analysis indicated which farm characteristics were associated with a desire to use woodlands commercially. The results are interpreted within the framework of developing outreach programs to attract farmers to actively use their land. In this vein, we worked closely with a farm operator to develop the economic data necessary to evaluate the benefits and costs associated with commercially managing woodlands. The result was a generic plan that other land owners who had participated in an earlier sondeo are evaluating. The results are presented in terms of a plan for integrating woodlands into the planning of the whole farm operation.

THE ECONOMICS OF EROSION CONTROL THROUGH AGROFORESTRY ON NORTHWEST MISSOURI FARMS <75

William Kurtz, Steven Thurman, Michael Monson

Agroforestry, the interplanting of trees and agricultural crops, provides an alternative to conventional soil conservation practices and offers the possibility for farmers to gradually remove marginal cropland from production. This practice is felt to be especially applicable to northwest Missouri where cropland erosion rates are the highest in the state. A long-term study was initiated in 1987 to evaluate the economic and biological aspects of adopting agroforestry systems by area farmers.

Three representative farms of 40, 160, and 640 acres were developed for each of two large areas of northwest Missouri. Agroforestry regimes were constructed for each farm to reduce soil erosion from typical crop rotations on highly erodible soils to tolerance (T) levels. Tree species included in the strips were black walnut (*Juglans nigra* L.) for timber and nuts, Scotch Pine (*Pinus sylvestis* L.) for Christmas trees, and American Sycamore (*Platanus occidentalis* L.) for industrial fuelwood. Terracing and grass strips were also included as a basis for comparing agroforestry with conventional conservation practices for typical crop rotations.

Christmas tree production yielded the greatest Soil Expectation Values. Furthermore, agroforestry enterprises (except biomass production) were found to be more profitable over the long run than conventional cropping systems utilizing conservation measures. Economies of size were noticeable among the different farm sizes.

Agroforestry may not only provide a means of economic diversification for farmers by the addition of revenues from forestry products but may also yield significant soil conservation benefits. Agroforestry is a low-input alternative to terracing for sustained production and erosion control.

WHOLE EARTH DECISION SUPPORT SYSTEM <76

Jerry R. Lambert, Renee S. Deter

A multitude of documents on a wide variety of subjects is distributed throughout the U. S. agricultural research and education system. Subject matter, expertise, news, software and research results are presented in text, numerical, graphic, photographic and audio form in paper, magnetic, optical, film and on-line database format. Duplication of effort, unknown information and decreased effectiveness result.

Decision support consists of both the algorithms for making the decision and the information utilized by the algorithms.

Integration of information and coordination of effort across public and private agencies is an objective of the Whole Earth Decision Support System. Another objective is effective and efficient access by agricultural professionals to help in both their own work and client assistance.

The Whole Earth Decision Support System architecture provides for full-document delivery of digitized documents and references to non-digitized information. Individual software modules are embedded per se, with credit and maintenance by the originating author. Public and private on-line databases are accessed directly and credit is given to the host institution, who maintains maintenance. Selection of material to be included in the Whole Earth Decision Support System is by peer review panels of subject matter experts.

The Whole Earth Decision Support System workstation includes personal computer delivery of text, data, graphic, audio and video information from magnetic, optical and on-line sources. Current configuration includes hard disk, CD-ROM, laserdisc and modem access.

EXTENSION'S PERSPECTIVES ON SUSTAINABLE AGRICULTURE <77

Dave McNeal

To be sustainable, American Agriculture must become a more environmentally sound socially acceptable, globally competitive, and consistently profitable system. Policy maker, farmers, processors, distributors, and consumers and all Extension publics should expect the Cooperative Extension System to provide the leadership in catalyzing change to meet these needs.

Sustainable agriculture is grounded in the idea that systems are composed of forces and factors which must balance humanity's needs, wants and capabilities in long and short terms. Likewise, sustainable agriculture is a high knowledge, information intensive, management demanding system which relys on a balance of market response, free enterprise, technology adaptation, and environmental sensitivity to meet the needs and wants of society. Sustainable agriculture includes marketing, producing, processing, and distributing products that we currently accept, and many which we can't even envision.

The production components of a sustainable agriculture system must balance nature's contributions with the available array of chemical, biological and other technologies. Likewise, a sustainable agriculture system must be responsive to scientific developments which meet the criteria of sustainability.

Sustainability Agriculture is a concept which can embrace the concepts of organic, regenerative, diversification, and other components of the agriculture system. The application of methods, technologies, strategies and approaches within this concept must be tailored to current and expected sets of local, regional, and global needs and conditions.

78> LEADERSHIP DEVELOPMENT AMONG FARM WOMEN AS A MEANS OF INFLUENCING POLICIES IMPACTING FARMING SYSTEMS

Dave McNeal

Is it possible to have a united voice on any issue in American Agriculture? Who influences the policies that determine the way American farmers function in a global economy, especially since there are only 2 million farmers in the United States? Women leaders of 10 agriculture-related organizations representing over one million memberships have united to form a leadership network selecting issues which can be addressed collectively. This presentation will describe the network, its focus and accomplishments to date, plans for the future, as well as a description of each of the organizations.

79> USING STRATEGIC PLANNING TO ACHIEVE SUSTAINABLE AGRICULTURE

Tom R. Troxel, Larry D. White

Management of agricultural enterprises commonly emphasizes the production process and obtaining maximum yields through adoption of technologies. Government programs have also concentrated on yields and acreage allotments for various crops as mechanisms for "stabilizing" production and "reducing risks" through relief, disaster and "subsidy" programs. Each management decision whether on the farm or ranch or at the county, state or national level plans to achieve certain objectives. Many of these decisions are crisis management oriented and may result in short-term solutions that jeopardize resources and long-term survival.

Strategic planning uses a management-by-objective approach for achieving long-term goals through selections of short-term alternatives that effectively utilize existing resources. The short-term solution is not acceptable if it results in resource deterioration that jeopardizes long-term goals. If sustainable agriculture is the primary strategic goal for the nation, state, county and farm or ranch, then management decisions that do not maintain or improve resources would be unacceptable even if they ameliorate crisis situations. Strategic planning in a systematic manner can improve analysis of management decisions that provide adequate compromise for "succeeding" today with "knowledge" of future impact on long-term goals.

STRATEGIC PLANNING: SELECTING THE RIGHT THINGS TO DO

What management achieves is more important than what is done (within existing constraints eg. legal, moral, social, etc.). Rather than deciding what to do, a manager first identifies needed responses to achieve goals, then selects the most appropriate way to achieve those responses. There are three basic steps used in Total Ranch Management that apply to successful use of strategic planning and management: 1) Planning from strategic goals to tactical solutions to operational flow of resources and selection of technologies, 2) Implementing and controlling management of al activities and resources, and 3) Making adjustments and replanning when situations and forecast of likely responses do not "best" meet performance standards for achieving goals. Even goals may not be realistic and have to be changed, especially over time as values and/or other priorities become more important. Management plans from the top down but implements and controls from the bottom up. The strategic goals are the driving forces for effective ranch and family management. These goals must be realistic in view of current requirements for success, resource constraints and expected future conditions. Because of differences between individuals and associated resources, different alternatives will be selected with different degrees of success at achieving sustainable agriculture. Strategic planning and management is a valuable approach to better achieve personal, community and national needs.

The Total Ranch Management program in the Texas Agricultural Extension Service has been developed to provide clientele guidance on effective integration and management of resources for achieving strategic goals. Total Ranch Management is the balancing of resource uses for sustainable ranch and family benefit. It directs ranch change while maintaining diversity and flexibility to meet future demands.

Total Ranch Management identifies where you are with your ranch business, where you would like to go (ranch and family goals), and how you plan to achieve these goals. With this concept, one of the primary philosophies of Total Ranch Management is to emphasize the importance of planning from the general to the specific or from the top-down through strategic planning. Because of this top-down planning, it is the strategic goals that governs the management of the ranch and not the daily activities. Tactical solutions (yearly objectives) determine the production standards (calf crop, lambing percent, etc.) for each enterprise. Operational priorities are everyday ranch activities that best accomplishes the tactical solutions. At each level of planning so that management can effectively monitor and make adjustments.

Eight general planning steps are used in evaluating he allocation of all ranch resources and the selection of appropriate management alternatives. The process is cyclic with continual will seldom remain unchanged for very long. Those that remain static will likely, be victims of the next crisis.

Eight Planning Steps For Selecting The Right Things To Do

- Establish long-term strategic ranch goals.
- Inventory all ranch resources.
- Identify potential enterprises.
- Develop general production processes for potential enterprises.
- Identify expected income, expenses and gross margin per production unit.
- Select the best combination of enterprises.
- Develop detailed production plans and a calendar of activities.
- Develop a resource "cash flow" by months.

HAS TOTAL RANCH MANAGEMENT MADE A DIFFERENCE?

The major Total Ranch Management educational effort is an eight day rancher workshop. Participants have been very commendatory about the program. Participants have adopted strategic planning and management practices never before used on the ranch.

SUMMARY

Most ranches today are faced with increasingly frequent crisis management decisions. A rancher completely satisfied with the current situation need not change but tomorrow may be another story. It takes time to change and Total Ranch Management requires more indepth planning and application than many ranchers are accustomed. Changing values require subtle but important changes in how management thinks about the resources which it manages (Hays, 1984). The fundamental purpose of strategic management is to effectively position and guide the firm within a changing environment (Pearce and Robinson, 1985). Successes and failures will continue to impact all ranches, but the real impact will differ depending on the selected ranch goals, necessities, available resources, and thoroughness of management.

The Total Ranch Management concept provides an integrated approach to ranch management. Success or failure still depends on management. Advancements cannot replace management, they are simply tools available when and where needed.

80> COMPUTER NETWORK FOR SELECTING AGRICULTURAL ALTERNATIVES

Luther Waters, Richard Levins

While so-called "alternative enterprises" received much attention

in the 1980's because of their economic potential, it may be the environment which motivates farmers to consider them in the 1990's. Modern agriculture uses a variety of fertilizer and chemical products which have come under increasing scrutiny for adverse effects on the environment. At times, public concerns lead to circumstances which make production of certain traditional enterprises impractical or unprofitable. In other cases, the "alternative enterprise" may be a familiar product produced in a more environmentally acceptable manner.

We propose a method for helping farmers gain knowledge of and select among alternative enterprises and production practices which have been identified throughout the country. Briefly, our method includes building and maintaining an information system of possible enterprises which have been identified by research scientists or innovative farmers. For each enterprise, information will be stored on its soil and weather requirements, production practices, labor and equipment requirements, and marketing prospects. We will also develop a method for helping farmers select which of the new enterprises they identify as best suited to their farming situation.

We will build a working version of the system for the state of Minnesota. This will serve as a model which can be extended for work of regional, national, or international scope.

SPECIAL SESSION: PANEL PRESENTATION
Making Sustainable Agriculture an Effective Tool for International Development

81> TITLE XII INSTITUTION CAPABILITIES AND INTEREST IN WORKING ON SUSTAINABLE AGRICULTURE AS A TOOL FOR INTERNATIONAL DEVELOPMENT

Clive A. Edwards

This presentation will consider the capabilities and kinds of activities U.S. Universities would need to take on sustainable agriculture if it becomes a development assistant goal of U.S. foreign assistance. These will include:

(1) Development of research, teaching and extension Sustainable Agriculture Programs in U.S. Universities.

(2) Changes in University development activities, particularly with regard to training of foreign and U.S. students in sustainable agriculture. This would include, collaborative relationships with L.D.C. institutions and Agricultural Research Centers and buildings of local infrastructures for extension and training of farmers.

(3) Change in University structure and function in terms of reward and incentives to faculty for long-term interdisciplinary research, and encouragement of international development work.

(4) Modification, coordination and increase of funding channels from AID, PVO's and other donor organizations to provide for long-term interdisciplinary, inter-institution programs in developing countries.

82> USAID/S&T INITIATIVES ON SUSTAINABLE AGRICULTURE

Thurman L. Grove

The roles of the Bureau for Science and Technology include technical leadership to A.I.D., technical assistance to field missions and regional bureaus, and applied research. This presentation will discuss S&T's activities to fulfill these roles in sustainable agriculture. S&T has provided leadership through close interactions with international and domestic environmental and agricultural communities that are concerned with sustainable agriculture. S&T provides technical assistance to field missions by synthesizing and communicating the results of these interactions to them and through centrally funded programs which are available for design and implementation of field programs. S&T has long sponsored research on components of sustainable agriculture including FSR, but is in the early stages of developing the capabilities in interdisciplinary and agroecological research that are fundamental to sustainable agriculture.

83> PVO AND NGO PERSPECTIVES AND ACTIVITIES ON SUSTAINABLE AGRICULTURE

Richard R. Harwood

The following is a first cut at my abstract. The title "PVO AND NGO PERSPECTIVES AND ACTIVITIES ON SUSTAINABLE AGRICULTURE". Dr. Richard R. Harwood, Regional Director/Asia, Winrock International Institute For Agricultural Development is fine.

Increasing amounts of resources for development are being channeled through private voluntary organizations (PVOs) in the U.S. and non-governmental organizations (NGOs) as they are called in developing countries. These organizations are nearly always oriented to "grass roots" impact. Their development agendas nearly always involve strong human well-being and environmental-protection dimensions.

The sustainable dimensions of agriculture are thus of major interest, with often heard criticism from NGOs of the narrowness of "official" development programs and their often unfavorable impact on the environment and on the lives of rural people. There has been a major gulf between the NGO community and scientific institutions because of the differences in philosophy and in development goals. With a move by mainstream scientists toward sustainable agriculture and an increasing understanding of organic, agroecological and other approaches commonly used by NGO groups, the communications gap is narrowing and ideas and appropriate technologies can hopefully flow more freely in both directions. The major agenda items will be enumerated. Examples of NGO involvement with several philosophies will be given for Asia.

84> BIFAD'S EFFORTS TO FORM A NATIONAL STEERING COMMITTEE ON SUSTAINABLE AGRICULTURE DEVELOPMENT AND NATURAL RESOURCE MANAGEMENT

John Ragland

The presentation will trace the evolution of A.I.D.'s current emphasis on sustainable agriculture and natural resource management. Emphasis will be placed on BIFAD's efforts to combine the academic, environmental, NGO and PVO communities with A.I.D. for the purpose of finding a common agenda for sustainable agriculture and natural resource management. This integrative effort has the aim of estimating the types and levels of political and financial assistance which will be required to make sustainable agriculture a comprehensive and effective tool for development.

Suggestions will be included in the presentation on how farming systems methodologies are becoming core ingredients for the sustainable agriculture initiative.

GLOBAL SESSION: FSR/E AND THE CONCEPTS OF SUSTAINABILITY

PLENARY ADDRESS: CONCEPTS OF SUSTAINABILITY <85

Peter Hildebrand

Farming Systems Research and Extension (FSR/E) has strongly influenced the direction of agricultural development over the past two decades, involving farmers, change agents and researchers alike, this participatory approach to technological improvement has evolved as an efficient means to develop individual components and more integrated systems that are uniquely suited to specific biophysical and socioeconomic conditions. Farmers with similar conditions and for whom specific Recommendation Domains. The technologies recommended conform with the biophysical and socioeconomic constraints which create the environments within the domains, based on the philosophy that new technologies must conform with the environments where they will be used because most farmers are unable to modify their environments to meet the needs of new technologies. This characteristic differentiates FSR/E from the now through the use of machinery, chemicals, irrigation and other capital-intensive inputs.

The philosophy of sustainable agriculture is gaining ground in a world becoming acutely aware of finite fossil fuel resources and adverse impacts of agriculture and other industries on the environment. In spite of substantial advances in productivity through applications of some new technologies -- fertilizers, pesticides, irrigation -- we are learning that inappropriate or excessive use of these inputs can have unexpected and undesirable effects on the environment, the natural ecosystems and the world's human inhabitants. In order to develop systems that will provide for our needs without endangering the potential for future generations to meet theirs, we must concentrate on an efficient use of renewable resources that are available within the immediate production environment, as well as reduce fossil fuel use to minimum essential levels. In other words, we must develop technologies that conform more closely with the environments where they will be used. The urgency associated with coming to grips with the problem is becoming more evident every day. These necessities precisely coincide with the capabilities of the FSR/E approach.

FSR/E practitioners work with families who lives on the land and are acutely aware of their surrounding environments and how they are influenced by cropping and farming practices and systems. Because farmers participate in the evaluation of alternatives, their evaluation criteria will be used for screening rather than the narrower and often misleading disciplinary criteria mostly used by trained researchers. This aspect, in itself, enhances the efficiency and effectiveness of the technology development and adoption process. Further, by taking directly into account the farmers' concerns and resource base, technologies are more readily adapted to the farmers' environments.

Perhaps most important, FSR/E on-farm research and technology evaluation methods have proven efficient for screening and selecting technologies which conform to the divergent environments found on farms throughout the world.

SUSTAINABILITY AND AGROFORESTRY <86

Marcelino Avila

The increasing concern of international research and development organizations with the recent poor performance of the agricultural sector, particularly in the African continent, has led to a search for new directions and strategies to address this problematic situation and its causes more effectively. Even in developing countries which have experiences notable increases in agricultural productivity through the successful adoption of technological innovations, the so-called second generation problems of the Green Revolution, i.e. the inequitable distribution of benefits, environmental pollution and displacement of the rural labor force, have mitigated against sustained agricultural development and food security. This trend of the 1980's continues in spite of large investments in technology generation, eg. the international Agricultural Research Centers (IARCs), and the explosion of scientific and technical information available to the national agricultural research and extension systems (NARES).

One of these new direction relates to the whole question of sustainability which has attracted the most interest and discussion among the international and national research and development leaders, and international donor community. Since the very essence of agroforestry is grounded on the concept of sustainability, in the sense that it is the reason that trees are managed by farmers in a dynamic and interactive manner with crops, grasses and animals, ICRAF has developed and applied conceptual and methodological procedures that have much to offer to the ongoing discussion on the topic of sustainability.

In this respect, the objectives of this paper are to present a conceptual framework for the analysis of sustainability within a systems perspective, to identify critical opportunities and challenges for agroforestry, and to discuss their implications for agricultural research and development.

DEVELOPMENT OF SUSTAINABLE TECHNOLOGIES FOR THE SMALL FARMERS OF AFRICA <87

Vethaiya Balasubramanian, Leonard Sekayange

This paper discusses the importance of a thorough understanding of the traditional production systems before proposing interventions to improve their productivity. The results of a Farming Systems Research (FSR) project in Rwanda used to illustrate the concepts of sustainability in the development of new technologies.

Rwandan farmers practice an intensive form of organic agriculture which has been evolved over generations. Resource recycling and conservation are an integral part of the traditional systems. However, these systems are subjected to sever strains under heavy demographic pressure (450 persons per km^2 of arable land). Evident everywhere are the consequences of excessive pressure on land: overexploitation of croplands and pastures; deforestation; clearing of fragile marginal lands for cultivation; serious (in some cases irreversible) soil degradation; and increasing scarcity of food, fodder and wood.

The Bugesera and Gisaka-Migongo (BGM) regions situated in the south-eastern part of the country (Fig. 1) represent the case of marginal lands, previously reserved for cattle grazing, being brought under cultivation. The climate is semiarid with unpredictable rainfall, the soils poor and fragile, and the rural infrastructure inadequate. The challenge here is how to improve food production on a sustainable basis on these poor soils.

The FSR project studied the local production systems, identified the constraints and opportunities in them, documented the practices that farmers employed to overcome the constraints and proposed the interventions to complement the farmers' efforts to increase and sustain production (Table 1). It should be emphasized here that

traditional production systems and active farmer participation are the focal points in the FSR approach to develop viable alternatives for the improvement of productivity. In some cases, the farmers' practices were so well developed that it is impossible to propose better alternatives to them; in such cases, those practices were chosen for extension to other farmers. The research interventions listed in Table 1 retain the essential ingredients of sustainability: (1) efficient recycling of organic matter and nutrients through composts, animal manures, green manures, crop residues, legumes, fallow vegetation, trees and crop rotations and associations; (2) soil protection and conservation through better crop cover, mulching and erosion control; (3) addition of biological nitrogen; (4) reduced incidence of pests through diversity of crops and production systems; and (5) on-farm generation of inputs and less dependence on purchased, external inputs. These systems do require a supplementary addition of nutrients such as P, Mg and Zn under continuous cropping over long term. These systems satisfy the multiple needs of small farmers: food, fodder, wood and employment. Stresses of economic (changes in market demands, price ratio of inputs/outputs) and social nature are not considered in this analysis.

Table 1. Identified constraints to food crop production in the BGM regions and the farmers' responses and researchers proposed solutions to tackle them.

CONSTRAINTS	FARMERS' PRACTICES	RESEARCHERS' RECOMMENDATIONS
1 Low and poorly distributed rainfall	* High density and staggered planting	* Early variety: Sorghum 5DX-160
	* Drought resistant crops: sorghum, cassava, sweet potato	* New drought resistant crops: soybeans, pigeonpea
	* Mixed cropping	* Improved intercrops
	* Short cycle crops: beans	* Better soil moisture status through improved soil O.M.
	* Overlapping mounds	* Confirmation of the efficiency of overlapping mounds
	* Dry season cropping in valleys	
	* Mulching: coffee, banana	* Mulching for food crops
2 Scarcity of arable land	* Cultivation of marginal lands	* Better cropping systems: alley cropping, planted fallow, intercrops and rotations
	* Reduced fallow periods	
3 Declining soil fertility and crop yields	* Manure/compost	* Manure/compost with supplementary fertilizers
	* In-situ composting of weeds & fallow vegetation	* Green manure
	* Mulching	* Improved mulch sources
	* Mixed cropping and rotations	* Better crop associations

Continued

Table 1. continued

CONSTRAINTS	FARMERS' PRACTICES	RESEARCHERS' RECOMMENDATIONS
4 Soil erosion and degradation	* As in 3 plus	* As in 3 plus
	* Natural fallows	* Planted fallows
	* Overlapping mounds	* Contour hedges
	* Anti-erosion trenches	
	* Minimum tillage for sorghum after beans	
	* Ratooning sorghum	
5 Lack of pasture and fodder scarcity	* Communal grazing and stall feeding	* Planted fallow
		* Alley farming
	* Crop residues as fodder	* Fodder trees
6 Firewood scarcity	* Scattered trees in farms	* Alley cropping
	* Community forestry	* Private woodlots
	* Crop residues/weeds	* Trees on contour
7 Attack by pests and diseases	* Mixtures: beans, banana	* Alternate crops pigeonpea
	* Higher plant density	* Local resistant varieties
	* Mixed Cropping and rotations	* Intercrops and rotations
		* Cultural pest control: Change in pigeonpea planting date

88> THE CONTRIBUTION OF FARMING SYSTEMS APPROACHES TO SUSTAINABLE AGRICULTURAL DEVELOPMENT

Michael Daw

The drive is on to concentrate agricultural development effort on improvements which are self sustaining - in terms of agricultural productivity, the maintenance of natural resources and in terms of long-term economic viability. Foreign governments and development agencies are increasingly realizing that long term problems are rarely solved by large, unselective injections of aid. A careful analysis of the local situation and a critical assessment of the long term effects of projects are increasingly essential before investment.

Farming systems work has much to offer here. It desegregates the farm-household complex into component parts, and analyses the relationships between them. It examines the farm and family in the context of the external environment (natural resources, markets, employment, rural services etc.). It leads to the identification of the most limiting constraints on production (or profit, growth or "well-being"), and it enables the planner to "test" the effect of possible interventions, on the farm, home and community, and on the external environment. Only by understanding the various inter-relationships of "the system" is it possible to foresee all the ramifications of a project and so judge its long term sustainability - in biological, social and economic terms.

Furthermore, since farming systems work inevitably focuses on the grass roots, its practitioners have the opportunity to fully involve local people in discussions of local problems and possible solutions. The approach is naturally "participative", and contrasts with the "top down" methods commonly used in conventional project formulation. This confers two advantages - solutions should be more appropriate to local needs, and there should be more local support and commitment to projects which are formulated with local participation. Both these advantages will lead to projects which are much more likely to be sustainable since they are locally rooted and supported.

Thus, a "farming systems approach" to development is

potentially powerful in preparing appropriate and sustainable projects. These ideas were tested recently in FAO's Farming Systems Development project in Ethiopia. The aim was to develop a method which combined the analysis of farming systems with local participation in identifying constraints and planning improvements. The results of the first two years' experience are useful in assessing the scope for this approach in formulating sustainable developments.

The main conclusions were as follows.

1. It is feasible (even in remote areas with no basic information) to analyze the farming systems group and individual interviews, and to use this to specify key constraints and to provide a base for participative discussions leading to local "micro projects". In other words, the approach can be made to work in practice.
2. It is highly likely (though too early to prove) that such projects will be sustainable since they were preceded by a reasonable understanding of the farming systems and local external factors, they were tailor-made for local needs, and local people felt committed to make them work.
3. Locally-derived projects are likely to have several different types of component (eg. include livestock and crop inputs, agriculture and social service, provide "hardware", training and organizations). Such plans are small "integrated rural development projects" and will vary from community to community.
4. This process of planning, using systems analysis plus local participation, is slow and costly (eg. per $ of development assistance) compared with the more typical project preparation methods where projects are often simpler, centrally-derived and large-scale. Whether the obvious disadvantages of "top down" approaches are offset by their speedier implementation is still an open question which has much to do with sustainability.
5. The FSD approach is, so far, more attractive to the smaller agencies and NGOs which have a local focus and which are able to support a wide range of possible interventions.

The quest for sustainable agricultural development is bound to accelerate in the future, leading to calls for more sensitive project planning and a greater awareness of the wider issues. The practitioners of farming systems approaches must be ready with tried and tested methods which enable the planners and developers to see clearly the ramifications of possible interventions and to choose those which are sustainable and locally acceptable.

PAST DEVELOPMENT AND FUTURE POTENTIAL OF THE METHODOLOGY OF FARMING SYSTEMS RESEARCH <89

Werner Doppler

The definition of farming systems and farming systems research differs widely and reflects the fact that research disciplines with different methodologies and experiences come together at different levels: natural sciences, such as crop and livestock production, and social sciences, such as economics, socio-economics, management and anthropology meet exactly in the sphere of farming systems and farming systems research.

Farming systems research has a long tradition. In Europe, agricultural research in the last 200 years developed a large variety of concepts and ideas which resulted in a systems approach in the first half of this century. A number of lessons can be learnt from that history which are useful for the situation in the tropics and subtropics today. In this paper those considered most relevant are included in future proposals.

In current farming systems research, the diversity in concepts is explained by the different methods and approaches applied. What is often called farming systems research can be grouped according to the method of data complexity and the level of the system or subsystem and the philosophy, rationale and strategy beyond the farming systems approach.

INFORMATION	SYSTEM	PHILOSOPHY
1. On-station research	1. Commodity based (often input or component based)	1. Farming systems research *sensu stricto* (FSR)
2. On-farm research	2. Production systems (cropping systems,livestock production systems)	2. On-farm research with farming systems perspective (OFR/FSP)
3. Base-data research	3. Resource based	3. New farming systems development (NFSD)
4. On-station and off-farm research		
5. On-station, on-farm and base-data research (M+E)		

There is a growing impression that the development of the number of innovations may be inverse to their effect on the needs and goals at the micro and macro levels. Impact studies which might clarify this issue haves not yet been conducted. These fields will need more clarification and streamlining in future. A basis for this is the analysis of the problems of the commonly applied farming systems research approaches. These problems can be summarized as follows:

(a) Only a part of the farming system which exists in reality is investigated.
(b) Farming systems research concentrates on the development and testing of technical innovations generally with the main emphasis on intensifying production. Other fields are neglected.
(c) Decision-making at the micro level is usually not included in farming systems research.
(d) The economic element of the farming systems approach is very often a short term type of analysis or calculation. Long term decision-making and sustainable socio-economic development is still neglected in empirical farming systems studies.

In trying to overcome the problems inherent in the current approaches, a concept is needed based on the following rationale:

(a) The adoption of innovations depends on decisions made in farms and the decisions are determined by goals. Decision-making oriented research considers the family, the farm and household as one system. Those who make decisions concerning the farm and the household do so in the light of their problems and objectives. Any testing of innovations must measure the impact of that technology on the objectives of the decision-makers. Sustainability of development is only feasible if innovations, activities and measures meet the objectives of the decision- makers. This is valid for the micro as well as the macro level. Adoption will indicate the degree of impact at the micro and macro levels.
(b) Farming systems development is, by its very nature, an issue of long term development. The inclusion of the physical, economic and administrative environment, the relevance of the resources available which can be improved by conservation measures, exploited, used in various ways, and extended through investment - given a certain mobility as well as yearly and seasonal fluctuation in production - processing, and storage, require a dynamic approach which includes the aspect of risk.
(c) Farming systems development has to be seen as a part of regional development from the micro as well as from the macro point of view. In reality in a region various types of farming systems will be found which can be analyzed following farming systems research *sensu stricto*. The qualification of the impact of innovations on various groups of systems allows the elimination of the negative effects of certain innovations on specific farming systems and an estimation of potential innovation and system with the highest possible adoption rate.

The principles and methods developed and applied in the history of farming systems development provide the possibilities for a more holistic and complex approach. The problems of the current farming systems research concepts show the need for including such an holistic approach in applied farming systems research. The basis of such an approach must be an orientation towards decision-making and behavior at the micro as well as at the macro level. This leads to the definition of farming system which focusses on the objectives of the decision-makers and this includes the farm as well as the household as the area of action at the micro level. At the same time, the long term aspects reflected in areas like risk and potential resource use have to be incorporated in order to include the dynamics of decision-making under changing circumstances. Furthermore, an assessment of the impact of the introduction of innovations is required before transferring them to the farmers, both during adoption and after the adoption process. This allows the evaluation of innovations, the quantification of the relationships between the micro and macro levels (internal and external relations of a farm) and is of special importance for extension services, defining research programs and for policy decisions. Some ideas concerning future methodology in farming systems research have ben developed and need further improvement. What is of equal importance is the application under practical conditions of farming systems research. The need for this cannot be surmounted simply by substituting the term farming systems research with resource management research which might attract more funds for a short period.

90 > ELEMENTS D'APPRECIATION DE LA VIABILITE DES SYSTEMES CULTURAUX EN AGRICULTURE TRADITIONNELLE: LE CAS DE LA REGION CENTRE DE COTE D'IVOIRE

Sekou Doumbia

91 > CONSTRAINTS TO SUSTAINABLE AGRICULTURAL DEVELOPMENT IN AFRICA

Timothy R. Frankenberger

In Africa, the rural poor are caught in a cycle in which deteriorating economic conditions have increased their reliance on rural production systems. Rapid population growth has intensified human and animal pressure on already fragile soils and vegetation. Fallow periods have been progressively reduced so that the soil has less opportunity to regenerate naturally. Marginal lands have been brought under cultivation with resultant increases in soil erosion. Systems which permitted the simultaneous maintenance of ecological stability and site productivity may no longer operate or have become inappropriate to the more intensive land use needed at current population levels. All of these factors are contributing to resource degradation, the loss of biological diversity, and threatening food security.

Donors such as USAID recognize the need for a more concerted effort on environmental protection and the preservation of biodiversity. Programs have already been initiated which focus on: 1) the integration of the maintenance of natural resources and agricultural efforts; 2) increased institutional capacity to deal with natural resource issues; 3) support for small holder participation; 4) long-term commitment; and 5) coordination with other host country initiatives and other donors. Despite these good intentions, the sustainability of African agriculture is problematic (Baker and Chapman, 1988). It will take decades of investment in institutions, infrastructure, and human capital at very low rates of return.

Before we can determine whether sustainable agriculture is possible in Africa, we must first determine what we mean by sustianability. Numerous definitions of sustainability exist. According to Douglas (1984), one focus of sustainability is on national food self-sufficiency or food security. Sustaining the natural resource base is important but secondary. developing country governments are most concerned with this type of sustainability and with support policies that help achieve this goal. Another focus of sustainability focuses on stewardship. Agricultural systems that deplete, pollute, or disrupt the ecological balance of natural resources should not be sustained, but should be replaced with systems adapted to long-term biophysical constraints. Although these two approaches to sustainability are complementary, an over-emphasis on food security at the policy level can lead to conditions where subsidized externally purchased imports dominate at the farm level. There is also a real danger that the effort to satisfy short-run demand will do irreversible damage to long-term agricultural potential.

Thus, although we can define sustainability in the ideal, it is much more difficult to operationalize. Aside from identifying what should be sustained and by whom, we must also consider the time frame and the costs of such efforts.

The key question to ask is how do we improve the quality of life in one environmental system without negating or impairing activities to improve the quality of life in another environmental problems remain secondary to economic development or survival.

This paper focuses on a number of major constraints to sustainable development that now face many countries in Africa. Although not mutually exclusive, these constraints exist at the farm level, institutional level, national policy level, within developed country policies and in donor support. aT the farm level, rapid population growth rates have forced farmers to either intensify agricultural production or to expand into marginal areas. The poor are concerned with their immediate livelihood rather than the husbandry of resources. At the institutional level, national agricultural research systems have focuses on research activities that concentrate on maximizing production based on the availability of external inputs such as chemical fertilizers, pesticides, mechanization, and irrigation (Frances, 1987). emphasis on food self-sufficiency and food security at the policy level has placed pressure on research organizations to maintain this short-run focus, de-emphasizing the importance of establishing institutional capacity to carry out research on sustainable agriculture. At the national policy level, maintenance of low food prices in urban areas may override efforts to strengthen sustainable development. IN addition, balance of payment debt and overvalued exchange rates have also discourage investment in agriculture. In addition, the aggregate demand for recurrent funds due to a large number of donor projects makes financial resources for sustainable development scarce. Sustainable development in Africa is also constrained by developed country policies such as the subsidization of agricultural production in developed countries. Such practices distort export markets and encourage greater dependency on developed countries' supplies of food grain exports. Constraints associated with donor support involve the political nature of development assistance and the emphasis given to project modes of development assistance.

Given the multi-faceted nature of these constraints, recommendations should b developed that systematically address each level. At the farm level, farming systems research can provide: 1) a detailed knowledge of the environment to be sustained and managed; 2) an awareness of the adaptive strategies that farmers pursue to live in their environments; and 3) an appreciation of the value that local organizations can play achieving sustainable development. At the institutional level, technologies, practice, and methodologies can be promoted by the national agricultural research system that contribute to sustainable agriculture (i.e., low input technologies, multiple cropping and crop/livestock integrated systems) (Frances, 1987). At the national policy level, more attention should be given to land use planning, soil conservation, reforestation and research on food systems. Finally, donors should give more support to national programs rather than creating parallel projects. This helps give direct attention to existing institutions to allow for sustained efforts.

FARMING SYSTEMS DEVELOPMENT (FSD) FAO'S REACTION TO THE CHALLENGE OF DEVELOPING SUSTAINABLE FARM-HOUSEHOLD SYSTEMS <92

Karl H. Friedrich

The paper analyzes the need for, the concept, methods and applications of FAO's Farming Systems Development (FSD) approach for developing farm-household systems on a sustainable basis.

The present situation with regard to FSR is reviewed. Although advancements in the field of technology development can be registered, FSR has made only a minimal contribution to the dissemination of technologies and implementation of appropriate policy and support systems. These shortcomings have stimulated the evolution of FSD.

The concept of FSD is introduced; objectives are described along with FSD's general philosophy and its embodiment into a systems context. Farming Systems Analysis (FSA), based on both ecosystems and socio-economic methods, is identified as a tool for creating better understanding of farm-household systems and their physical, socio-cultural and policy/institutional environment, and for orientation of the latter to development opportunities and appropriate support.

Methods and procedures utilized in FSD are described in this paper, especially with regard to their specifications and differing emphasis to similar approaches. Farm-household systems are analyzed. Constraints are identified which adversely affect the satisfaction of the multi-objective goals of rural people. The search, evaluation and testing of potential improvements lead to appropriate orientation of policy formulation, program adjustments and project analysis to enhance a balanced and sustainable development of farm-household systems and rural communities. The way the FSD concept and methods are applied at the various levels of intervention for promoting farm-household development is elaborated.

Major advancement in systems thinking, as required for FSD can only be realized through eduction, training and networking. FAO is presently engaged in developing a farming systems curriculum cased on strong outreach components; in developing and field-testing training course material in FSD, as well as networking FSD activities in sub-regional contexts. These activities are described in this paper.

INTEGRATING SUSTAINABILITY STRATEGIES WITH THE FARMING SYSTEMS RESEARCH AND DEVELOPMENT PROCESS <93

Robert D. Hart, Michael W. Sands

One approach to integrating sustainability criteria with the farming systems research and development proces is to identify the system that is to be sustained and then systematically consider different strategies that can make a system more sustainable. Two types of strategies are: (1) changing the internal structures of the system to make it less susceptible to external stresses or shocks, and (2) changing the relationship between a system and the natural resource base to insure that resources productivity is maintained or enhanced. Specific strategies within these two categories can be identified and a menu of potential technologies associated with each strategy can be developed. These specific technologies should be considered during the design phase of the FSR/D process and evaluated for their impact on system performances and resource productivity during the evaluation phase of the FSR/D process.

AGRICULTURAL SUSTAINABILITY AS AN OPERATIONAL CRITERION <94

Peter Hildebrand, Malik Ashraf

Agricultural sustainability is widely used and easily understood in casual conversation. The same is not true when the term is introduced into a more rigorous framework. The implications are very different when the term sustainable is operationalized as an evaluation criterion in (1) cropping systems, (2) human systems, and (3) ecological systems. This paper presents a means of evaluating the implications associated with attempts to modify sustainability. Included are considerations of (1) agricultural productivity (the cropping system), (2) environmental survivability (the ecological system), and (3) human population and income changes (the human system).

The procedure used to operationalize the concept of sustainability is by means of linear programming (LP). The farming system used as an example is representative of the area near Ijaye in southern Nigeria. The LP maximizes net income after meeting minimum subsistence requirements and subject to minimum land and labor constraints. Two sustainability equations incorporate agricultural and ecological concerns. One sustainability equation treats the "longevity" of the crop system and the other the "dependency" of the crop system on external chemical inputs (related to survivability of the environment).

Preliminary analysis indicates that human population density (reflected by are per farm) exerts more pressure on longevity than limiting chemical inputs. The latter have more immediate influence on income, although there is a limited substitution effect of chemicals on longevity.

Results reflect the need for substantial additional research information on the longevity potential of alternative agricultural production systems with varying levels of chemical inputs.

FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E) AND THE CONCEPTS OF SUSTAINABILITY AS APPLIED TO THE TRADITIONAL RICE PRODUCTION SYSTEMS OF LIBERIA, WEST AFRICA <95

J. K. Jallah, C. K. Mulbah, D. J. Davidson, J. Beebei

Shifting cultivation can be generally defined as a low input agricultural system in which land is cropped for fewer years than it is left fallow. The long fallow period permits the growth of deep-rooted trees and shrubs that maintain ground cover, recycle nutrients and restore fertility. It is the predominant food production practice on approximately 30 percent of the exploitable soils of the world's population.

Liberia is located int he humid tropics of West Africa. Many of the farmers (over 50 percent) in the region of Tropical Africa practice shifting cultivation. The system, as practiced in this country is considered a way of life geared towards meeting subsistent food needs. It is centered around the staple crops, rice and cassava. The major cropping pattern consists of mixed cropping of these and other minor crops in the uplands. Other production practices, considered integral components of the Liberian farming system, include the production of rainfed swamp rice in inland valleys, tree crops (mainly coffee and cocoa), sugar cane as a local cash crop, and livestock (chickens, goats, sheep, swine, and a limited number of cattle) using free-range methods.

There are a number of soil-related constraints that limit food production and impede agricultural development in Liberia. The native soils in Liveris are highly weathered, leached, and acidic. These soils are extremely fragile and are dominated by Iron and Aluminum oxides which pose serious production constraints. When the bush is cut and burned, at the end of the fallow period, there is a loss of potential organic matter and nitrogen sources and the soil is highly vulnerable to erosion. Furthermore, fertilizer and soil amendments necessary to correct the soil problems are either unavailable or unaffordable to the subsistence farmer. Socio-political constraints of concern are: a traditional beliefs, land tenure, poor infrastructure, limited markets, and government policy.

Given existing technology, shifting cultivation may represent short-term optimal allocation of land, labor, and low inputs. Shifting cultivation is labor-intensive and labor required to meet subsistence

food needs limits labor available for more productive enterprises. Traditional choices of cultivars have been based on minimizing risk and when combined with traditional agricultural practices, has resulted in below optimal yields. Increasing pressure on land-use has already led to a reduction in the ratio of fallow to crop periods in certain areas. This has resulted to less fertile land to work with which has further reduced yields below economic levels. this has further intensified the need to bring more and more valuable forest land into production.

In view of this, with the increasing population and finite area of land, shifting cultivation, as now practice, is not sustainable over time. There is a critical need to explore ways in which the system can be improved upon or replaced with agroecologically compatible, economically viable, and socio-politically acceptable alternatives.

Farming systems research and extension (FSR/E), adapted to Liberian conditions, has been proposed as a way to address this problem. The FSR/E approach is broad in scope and application. It can be viewed from the perspectives of a 'bottom down' or a 'bottom-up approach'. The bottom-down approach basically advocates efforts to improve on present traditional practices. Emphasis is on results that are of immediate benefit to the farmer. The key concepts of sustainability as related to the farmer. The key concepts of sustainability as related to the bottom-down FSR/E approach should center around economic viability in terms of labor productivity.

The bottom-up approach, on the other hand, has long term goals geared towards finding alternative farming systems that are productive, stable, sustainable and equitable. The key concepts of sustainability, as related to this latter approach should emphasize, not only labor productivity, but all measures that can ensure the maximization of outputs while conserving resources. Such a system must possess the following features:

1. maintain continuous ground cover, nutrient recycling and organic matter build-up,
2. prevent erosion and physical degradation of the soil,
3. maintain favorable conditions for soil fauna,
4. reduce pest and disease build-up,
5. require minimal inputs, such as labor,
6. and take into account socio-cultural conditions and change in these conditions over time.

In this paper, an attempt will be made to examine the key concepts of sustainability as they relate to FSR/E within the context of the approaches previously mentioned and how this applies to traditional rice production and shifting cultivation systems in Liberia, West Africa.

96> FARMING SYSTEM RESEARCH IN NIGERIA: SOME ISSUES THAT HAVE FAILED TO MAKE IT A SUSTAINABLE SYSTEM

Ravindra Kaul

Efficient production of food involves principles of biological technology (better seed, fertilizer, etc.) and physical technology (like devices for timeliness of operation, storage, water management, etc.). There has to be a proper blend of these two technology and normally the Farming Systems approach is expected to take an integrated and balanced view of these when introducing any improvement in an existing system. Gauging, however, from the negligible increases in unit yields of various crops in Nigeria and actual current levels of technology the success of the system is debatable, despite a decade of usage of Farming Systems concepts of research in the country.

There have been isolated so-called success stories on a few situations but these are generally short lived with no sustained continuity. Similarly even though it is recognized that over 99% of Nigerian farmers are small scale controlling over 80% of food production, any temporary noticeable thrust is from relatively larger 1% farmers.

This paper dwells on this apparent paradox by using selected case histories from Nigeria and underlines the fact that most failures have been because the innovations introduced did not have any built-in element for sustained retention and were not studied in real total system. Primary focus has been on selected biological (agronomic) practices with little or no attention to aspects of physical technology. Further the improvement introduced appear to have neglected the existing farmer practices and traditional processing which beautifully incorporates aspects of minimum tillage, water retention, varied crop mixtures and simple but novel food processing techniques.

The paper illustrates, with data, how by neglect of physical technology component, the constraints of labor shortage at peak operations, and inability to honor timeliness factors etc. are still existing and the small scale farmer continues to carry the age-old stigma of 'hoe-farmer' and he continues to practice same technologies as were used by hie forefathers several decades back. In fact his performance is on a declining level when viewed against large export of groundnut, cotton etc. that was taking place in Nigeria which items are now ironically being imported.

The paper concludes that an improvement to existing farming systems cannot be successful unless there is a real and total involvement of the system involving both biological, sociological and physical technology aspect. It should also have a built-in provision for sustained retention of any improvement being introduced. The paper further illustrates how, in fact, the current constraints as confirmed by research studies, are in fact heavily shewed towards biological aspect only with neglect of physical technology. It show how the research efforts at the Institute for Agricultural Research Zaria, Nigeria have identified these and evolved approaches for a sustained agricultural system.

Finally it pleads that the real Farming System approach is indeed the best provided the totality of components is considered and a provision of sustainability built-in the total package being recommended.

97> SUSTAINABLE FARMING SYSTEMS IN COASTAL WEST BENGAL: CONCEPT AND PRACTICE

B. Mandal, C. S. Das, Shanti Chakraborty, J. E. Gleason

This paper reports on the methodology and its implementation of a farming systems research and extension project in West Bengal. The project is one of the activities of the Ramakrishna Mission (RKM) in Narendrapur, West Bengal, funded by the Ford Foundation, New Delhi.

RKM's farming systems research project works in nine villages in coastal West Bengal. This area of India has not much benefitted by the advances of the Green Revolution because of its adverse environmental conditions. Constraints to agriculture production include low-lying lands, heavy soils contributing to poor drainage and water stagnation, a unimodel distribution of rainfall, with about 80% of a total average of 1750mm coming in the four months of June to September, saline soils in some areas, and scattered holdings.

The majority of farmers in this area have landholdings of 2 hectares or less and about 50% are considered below the poverty level. Farm income is supplemented by farm-allied activities such as animal husbandry and fishing and off-farm employment in neighboring urban areas.

The goals of this project are two-fold: (1) to introduce suitable techniques and technologies to increase productivity and cropping intensity in agriculture on a sustainable basis, leading to greater employment and income; and (2) to determine what farm-allied activities best utilize available family labor to generate income.

Agriculture in coastal West Bengal has not developed at the same rates as other parts of the state and other areas of India

because Green Revolution technologies did not fit the specific environmental and socioeconomic conditions of the area. The FSR project at RKM overcomes this problem by conducting applied and adaptive research consistent with farmers' criteria. The most important component of the project which is highlighted in the paper is farmers' research agenda, farm meetings are held in each village and participating farmers are asked to indicate their criteria for changes in agriculture. Based on statements of what they want and what they can afford, rice variety and fertilizer trials are conducted on farmers' fields. The on-farm trials are farmer managed and are such that they can be replicated by most farmers without input subsidies. In the areas where the trials have taken place there has been a substantial increase in the use of modern varieties.

In addition to on-farm trials, a homestead garden program has been initiated as a mechanism to include women into the project. Like the trials, FSR staff elicited the opinions of village women before finalizing the garden program. This program seeks to make systematic a traditional women's role in rural Bengal. It positively affected the participating families by increasing production of vegetables, raising incomes, increasing employment on-farm and provided for better nutrition. A larger percentage of women cultivate vegetables for market as a result of this program.

The success of RKM's FSR project is due to its heavy reliance on farmers' participation. Each season over 100 farmers participate in the on-farm trials and over 200 women cooperate with the garden program. Trained field workers live in the villages so that constant contact with participating farmers is maintained. This method of implementing an FSR project has resulted in sustained agricultural development.

This paper will discuss in detail the structure of RKM's farming systems research program, including adaptive farms, village youth clubs and training centers which allows farmers and others who are participating in the research to give important feedback to researchers. It will also discuss the actual research that was conducted with farmer participation. The paper also gives information on the results of the research and recommends how this type of research process can be used in other parts of India and Asia to lead to sustainable agricultural development.

ESTABLISHING CONGRUENCE BETWEEN FARMING SYSTEMS RESEARCH AND SUSTAINABILITY IN HIGH RISK REGIONS OF EASTERN INDIA <98

D. M. Maurya, K. C. John, R. K. Singh

With the advent of formal agricultural research and growing disciplinary specialization, farming systems have been viewed in fragmented manner. Subsequently, technologies emanating from the experiment stations were quasi-solutions and place undue emphasis on uniformity of research products - be it crop choices, varieties, nutrient replenishment, irrigation practices or other agronomic management practices. Quasi-solutions tend to be satisficing rather than optimal. Problemistic search in the organizational context compels agricultural researchers to focus their priorities on looking for problems which could be solved through their expertise, i.e. solutions in search of problems, rather than adopting creative problem solving approaches.

Problemistic search coupled with the institutional reward systems in vogue has induced researchers to concentrate on softer and risk-free issues: cereals vs. pulses, oilseeds and tree crops; wheat and rice vs. coarser cereals; irrigated agriculture vs. rainfed agriculture; crop enterprise vs. livestock enterprise; component technology in monocropping vs. farming systems context etc. are illustrations of emergent tendency of formal R&D. This has also make professional colleagues the most important audience of research rather than the farmer. In Indian context these tendencies were manifested in adopting the 'best bet strategy', that is, concentrating on agricultural research and development programmes on the most favorable areas. In operational terms it meant: evolving fertilizer-responsive high yielding varieties (HYV), emphasis on major irrigation schemes, channelling agricultural credit and other infrastructural services to well endowed districts and adoption of transfer of technology (TOT) model which focused on socio-behavioral traits such as: early adopter and laggards - thus working solely with large farmers. The impact of such a strategy is well documented - attainment of foodgrain production target of 175 m.t., a buffer stock of more than 30 m.t., etc. However, this strategy has also increased the spatial disparities, temporal variability, cytoplasmic homogeneity in the genetic composition of crops, making the crop vulnerable to pest infestation and increasing the chances of systems-collapse, increase in water-logged and saline-affected areas, and lesser control of farmer on resources used int he farming i.e. reliance on external purchased inputs. Though the agricultural productivity has increased in selected districts - nine districts accounting for 25 percent of incremental output while 147 districts together could hardly experience 25 percent increase in gross production (Bhalla and Tyagi, 1989). The spectacular achievements have been at the cost of stability and sustainability and entitlement (Hazell 1986, Sen 1981, Bhalla and Tyage, 1989). The preferred strategy has worked well in homogenous irrigated tract but excluded the rainfed high risk regions from its ambit.

The rainfed agriculture is characterized by heterogeneity in agro-ecological situations within a village. Tremendous variations in climatic parameter, unimodel rainfall pattern with more than 80 percent of precipitation being received during the south-west monsoon (July-September), erratic behavior within the rainy season, etc. make the water balance regimes to fluctuate. The edifice factors are also not uniform - variability in toposequence, native fertility nd other physio-chemical properties of soil, has also compelled farmers to use their ingenuity in adapting to the long-term agro-climatic features of the rainfed region and adjusting to the short-term weather aberrations. As a result, one finds diversity in enterprise selection and genetic composition of biotic enterprises; flexibility in resource use as well as agronomic practices which are contingent on weather patterns; rotation of crops designed as an effective risk-hedging mechanism and evolving nutrient, water- and pest-management. Thus the farmers have been exploiting the concepts of recycling, plurality of choice and multiple source - the basic tenets of sustainable system. Thereby enabling farmers, in the fragile environment, to retain autonomy and decentralized control over and access to natural resources. The resulting system is stable, sustainable, and equitable though low in productivity which incorporates portfolio choices with low mean -low variance. The Farming Systems research methodology evolved at Narendra Deva University of Agriculture & Technology, Faizabad (India) over the last four years attempts to take into cognizance the heterogeneity in agro-ecological situations prevalent in the rainfed region and exploits the risk-hedging strategies of innovative farmers in evolving a sustainable system. The endeavour is geared towards building upon farmers' informal experimentation and local knowledge systems, so that a stable, sustainable, equitable farming system could be evolved with high productive potential, i.e. (shift from low mean - low variance to high mean -low variance enterprise portfolio).

The emergent FSR concepts such as whole village concept - enabling maximization of variability in agro-ecological as well as management conditions; multiple choices - enterprises, genotypes and agronomic practices; farmers' participation in problem identification and location of experimental sites - (agro-ecological mapping), evaluation of experiments (group monitoring), impact assessment (horizontal diffusion), recycling (nutrients and water resources) and crop-livestock interactions, self-revolving (seed bank) etc. are explained. The congruence between concepts of FSR and sustainability are explored and substantiated with well documented empirical evidences. The implications in terms of future research and development strategies and policy innovations required at the macro - as well as micro-level for promoting sustainable systems are also examined.

99> THE TIME FACTOR IN FSR/E METHODS AND AGRICULTURAL SUSTAINABILITY

John O'Sullivan

TIME FACTOR - Time is now recognized to be a critical factor to be included in any extension or research effort looking at agriculture. However the scientific research paradigms of production or economics frequently assume away this factor or try to hold it constant. At the same time it appears as though traditional extension models and bureaucratic structure also neglects or undervalues TIME FACTOR.

Inclusion of a conceptual time frame of sustainability, recognition of the historical record, incongruities of the bureaucratic time frame, the public budgetary process time frame, extension programming implementation time frame, and agricultural time frame so recognized can impact on fsr/e program development within the human systems environment. Learning curve considerations both for ES personnel and farmers, establishment of linkages and credibility all require time. It is clear that as a model, fsr/e does provide an approach to including time in the paradigm with the concepts of domains, provided it is included in the model. The author's own work in Mali, Senegal and Guinea, West Africa point to the need for appropriate TIME FACTOR inclusion, in terms of future planning, present time management and past time experience.

SPECIFIC FOCUS OF THIS STUDY - THE PROGRAMMING TIME FACTOR - A series of interviews of farmers, paraprofessional agricultural technicians, professional agents, district directors and specialists in North Carolina, based at both NCSU and NCA&TSU has provided observations from a Small Farm Extension Program (the Farm Opportunities Program) in North Carolina. This program has been active in 10-20 counties over a 15 year period. While not explicitly fsr/e, it fits many of the conceptual guidelines of the approach. The qualitative data generated in the interviews (which were open ended and free form) completes observations based on the operational programming monitoring data collection instrument, the Benchmark form.

In terms of the Farm Opportunities Program of NCA&TSU with paraprofessionals the data show approximately a 24 month period is necessary to establish credibility – even with an on-going program. There is then a similar period in which the paraprofessional tries to do too much in terms of implementing all the various program thrusts he initiated in the first period. There is then a third period of maximum program effectiveness. Finally the problem of starting up again emerges as the cohort of cooperating farmers "graduates" and new cooperators must be found.

100> SYSTEMS AGRICULTURE - A PARADIGM FOR SUSTAINABILITY

Nadarajah Sriskandarajah, Richard Bawden, Roger Packham

In this paper we argue that in order to practice sustainable agriculture and to deal with its complexity, we require "systems" approaches. We examine the complimentarity of the concepts of Hawkesbury Agricultural College, and their relevance, in a global sense, to sustainable rural development.

Sustainability could mean different things to different people, depending on their viewpoint. From an economic viewpoint, sustainable agriculture is equated with low-input agriculture to mean sustainability of production and profits without the excessive use of purchased inputs. This is largely a viewpoint of commercial agriculturists in developed countries, primarily in response to the increasing concern for the danger from agrichemicals to health of people and their environment. An ecological viewpoint highlights the imbalance between the use of renewable and nonrenewable resources, again largely in commercial agriculture of Western countries, and calls for stabilization of yields and a homeostasis in agro-ecosystems. When one takes a wider, social viewpoint seeing agriculture not purely in its production role but also as a way of life of rural people, sustainability means the maintenance of stable, self-reliant rural communities.

Sustainability as a unifying concept that will guide agricultural practice in a global sense should accommodate all of the above viewpoints. Ruttan (1988) cautions us that if agriculture is to meet the demands created by growing populations and rising incomes in both the developed and developing world, sustainability must also include enhancement of agricultural productivity.

In our view, sustainable agriculture is inseparable from sustainable rural development. Agriculture is the central activity in rural populations. The practice of sustainable agriculture by people who think "sustainable" is the key to people-centered development. In the practice of agriculture and in the process of development, people are constantly interacting with their natural and social environments, and more importantly, learning from these relationships. To accommodate the complexity and change that characterize these learning relationships with their environments, people also have to think a holistic sense. Thus, thinking "sustainable" requires thinking in wholes rather than in component parts, thinking systemically. This thinking should then be integrated with acting, and with the peoples' own visions, beliefs, values and attitudes. New theories would emerge out of this integration, they in turn would inform the practice, and practice would constantly refine the theory. It is this notion of PRAXIS, of learning to be, rather than learning to know or learning to do, combined with SYSTEMS thinking which form the Hawkesbury paradigm of Systems Agriculture and commit it towards Sustainable Agriculture.

The challenges faced by sustainable agriculture as a global movement are many If the application of science and technology to agriculture gave us the impressive increases in production of food and fiber, at the same time depleting the resource base and damaging the environment, the challenge is now to design new agricultural technology and create new knowledge to sustain production and restore and maintain the environment. An even bigger challenge is to move from a narrow production focus that ignored people to one that will bring people and their relationships to the environment to the center of all our endeavors. This calls for a major shift in the world view of practitioners of agriculture and the professionals who help them, from a reductionist, mechanical one to an ecologic, relational, systemic world view. Conventional approaches to agricultural education, research extension that reduced and subdivided knowledge into neat compartments and disciplines would need to be modified to produce new agricultural professionals who would be better equipped to generate the necessary technology for sustainable agriculture in participatory, co-learning relationships with the people who practice that agriculture. Indeed, in such learning situations, education, research and extension become different faces of the one learning process.

Farming Systems Research and Extension (FSR/E) came about as a research methodology when agricultural professionals, particular economists, were prepared to transcend the confines of their disciplines and take a holistic, interdisciplinary view to solving problems in farming systems. The ideals of FSR/E as a dynamic, tierative, evolving approach are compatible with the concepts of sustainable agriculture. Sustainable agriculture needs rural communities for it to survive and flourish and a 'critical mass' of sustainable farms are required before the emergent qualities of it as a farming system appear over time (Jackson, 1984). Dedicated, long-term effort is, therefore, required to achieve the necessary change in attitude and the active participation of farmers, for sustainable agriculture to become a social movement. Furthermore, the alternative technology consistent with sustainable agriculture has to be generated on location, using formal and informal research approaches. For FSR/E to contribute to this process, it should change its image of a rigid, project-based, component and/or commodity-oriented, technical assistance package towards a more flexible, long-term approach that has the acceptance and active involvement of agricultural professionals in site.

The technocratic bias of agricultural professionals in general, and

the existing structure of agricultural institutions have limited the progress of systems approaches to rural development. Sinnoms (d1986) noted how conventional education of agriculturists was an impediment to the lateral thinking necessary for productive participation in FSR/E. It is in this area of education that we started a reform at Hawkesbury, over a decade ago, towards creating a learning culture where communities of people work together to learn their way through problematic situations. We replaced the conventional didactic paradigm of education with one that has as its base, systems thinking and practice, and experiential learning. We adopted a range of systems methodologies such as FSR, Agro-ecosystems Analysis and Soft Systems Methodology and integrated them with the four-stage process of experiential learning (Kolb, 1984; Bawden, 1988). Learners work through a number of agricultural problem situations choosing appropriate methodologies and techniques ranging from systemic to reductionist. New knowledge and new ways of knowing emerge from the flux between reflection and action, and the integration of theory and practice that results from it. Learning thus becomes a participatory process where students learn, not just to know the theory of agriculture nor just how to do things in agriculture, but how to be professional agriculturists.

As this learner-centered curriculum for undergraduate and graduate education evolved, we found ourselves committed to an ethic of sustainable, equitable and environmentally-responsible development. We have discovered an extremely relevant approach to our own development as individual academics, and to the evolution of our institution as a self-developing system which itself learns. Madden (1988) outlines the challenges of sustainable agriculture to the agricultural economics profession and these indeed are challenges to everyone involved in this movement. By sharing our experiences at Hawkesbury with the wider community, we may be able to offer insights which will help us face these challenges together.

COMPOSITE WATERSHED MANAGEMENT: A SYSTEM TO SUSTAIN AGRICULTURE ON ALFISOLS IN THE SEMI-ARID TROPICS <101

Matthias Von Oppen, Christa Knobloch

Objective: The objective of composite water management is to improve the combined use of surface and groundwater resources in a watershed in order to stabilize and increase agricultural production.

Erratic and undependable rainfall is one of the major constraints limiting agricultural production in the SAT, especially in regions with red soils (Alfisols) that have poor water retentivity. The traditional form of water management in these areas was tank irrigation.

Recently, however, groundwater is increasingly being used, which is drawn from shallow aquifers. Alfisols are derived from granitic rocks. The main aquifer in granites is the layer of weathered material extending down to a few tens of meters, below which the hard basement rock is rather impermeable. The depth of dugwells and borewells in such a situation is also generally shallow. Better management of water resources, including surface and subsurface storage, can help farmers to increase and stabilize production.

Background: Tank-irrigation technology has had a deep influence on the cultural development in many regions of India. Spatial distribution of tank irrigation has been determined primarily by physical factors such as hard rock substratum, vapor pressure, postmonsoon rains, low moisture-holding capacity of soils, and by population density. Tank irrigation, especially in southern India, is very closely interwoven with settlement pattern and village organization. Nevertheless, in many parts of the country, especially in areas of high population density, irrigation tanks are in decay and the area irrigated by tanks is declining.

There are three reasons for this decline in tank irrigation. (1) The human pressure on land transforms the environment and affects the performance of irrigation tanks; vegetation in the catchment areas decreases because of over-utilization; subsequent erosion and flash run-off cause siltation of the tank beds and breaches of tanks. (2) Alternative sources for irrigation water have been developed, especially well water lifted by mechanical devices. Public as well as private investments tend to favor these options over the traditional tank-irrigation schemes. (3) The administration of irrigation tanks is neglected, leading to increasingly inefficient water use which in turn accelerates the redirection of private investments. Irrigation tanks are increasingly being treated as common property resources, exploited without proper management, and degraded.

The Concept: The concept of composite watershed management (CWM) on Alfisols proposes a system of run-off and erosion-controlling land management for enhanced groundwater recharge and sustained well irrigation.

In other words, the fertile beds of the degraded traditional tanks in the valley bottom will be opened up for agricultural production, allowing for solar powered irrigation from shallow wells; to sustain the groundwater level and to control run-off and erosion, small ponds or terraced paddy-fields are established along the lower reaches of the watershed but above the level of the old tank bed. An organizational infrastructure to ensure adoption and farmer participation is an integral part of the design of CWM. This concept was analyzed at ICRISAT Center in various modelling exercises and it was found to have considerable economic potential.

In addition to its economic potential, CWM will have the socially desirable effect of providing more equitable access to water. It will also be beneficial to use the anticipated technology of solar-powered water lifting by ensuring relatively shallow water tables for effective exploitation.

Preliminary Studies and Results: In collaboration with other organizations, ICRISAT staff selected two Alfisol watersheds in Andhra Pradesh, South India, for composite water management studies.

In both watersheds, a traditional tank irrigation system has steadily been abandoned over the last two decades. Farmers now prefer to irrigate from wells and extensive exploitation of the aquifers has led to a fall in the water table.

To assess the potential of an improved water management system for such watersheds, researchers (in collaboration with engineers from the Department of Minor Irrigation, Government of Andhra Pradesh) focussed on the following aspects:

(1) Collection of socio-economic data on farm holdings, family sizes, cropping preferences, irrigation practices, income and their analysis in farm models as well as sociological studies.
(2) Collection of basic surface hydrological data on rainfall distribution meteorological parameters, water balance of tanks, etc., and subsurface information on water-table fluctuation, recharge, aquifer properties, physical surveys, and drilling wells; and analysis of these data in water balance models.
(3) Construction of check-dams and mini-percolation tanks with storage capacities of the order of 0.1 to 0.4 x $10^6 m^3$ on the basis of aerial photographs and ground verification of lineaments, slopes, and overburden thickness. These tanks are designed to have minimal evaporation loss and consequently an increased ponding period resulting in more groundwater recharge.
(4) Development of a small-scale solar powered pump, designed to lift water from shallow aquifers. A protype has demonstrated the feasibility of exploiting the Rankine cycle for small-scale solar pumps. The prototype lifts about 500 L water/h, over a head of 1 m. It is being improved.
(5) Follow-up surveys in farmers' fields to monitor the physical effects of percolation devices on groundwater levels and well-water availability and the economic effects of the system on the level and stability of farmers' incomes.
(6) Assessment of the overall impact of choice of irrigation technologies on the economic performance of the watershed as a whole.

The Challenge: Developing the guidelines for the design of a CWM-System is a challenging interdisciplinary task. Highly qualified disciplinary research is required to resolve partial problems and these pieces of research have to be coordinated into a well-focussed interdisciplinary approach; the location of most of this research has to be in farmers' fields, although some components have to be accompanied by on-station or laboratory experiments such as the development of agronomic innovations for supplementary irrigation or the improvement of a solar powered water lifting device. In addition, the sociological setting has to be carefully studied for implementation of the right administrative and organizational infrastructure which a composite watershed management system requires. At this level not only the goodwill and the cooperation of the farmers is required but also the political support from the local as well as the national government.

GLOBAL SESSION: THE ROLE OF FSR/E IN SUSTAINING PRODUCTIVITY AND PROFITABILITY

PLENARY ADDRESS: PRODUCTIVITY AND PROFITABILITY

SUSTAINABILITY, PROFITABILITY AND PRODUCTIVITY <102

John A. Miranowski

If we are to have an abundant and affordable food supply in the long run, a sustainable agricultural system is required. Sustainability is defined differently in various developed countries as well as differently between developed and developing countries. But our major concern in defining sustainability is the long run viability of the agricultural system, particularly maintaining the long run productivity of the land and soil resource base. Only under these circumstances can we help ensure long run profitability and productivity growth. The key factors in maintaining a sustainable, profitable and productive agricultural system is the research and information base, infrastructural investments, and the adequacy of market signals.

This presentation will outline the trade-offs between sustainability, profitability, and productivity for different agricultural production systems, as well as the economic consequences and implications for profitability and productivity of pursuing sustainability under different resource endowments.

AN ASSESSMENT OF THE IMPACTS OF SMALL FARMING SYSTEMS RESEARCH/EXTENSION ON SUSTAINABLE AGRICULTURE IN KENYA <103

B.K. Acquah

This paper examines the impacts that small farming systems research/extension have had on the productivity of small-scale farms in areas where these research/extension activities have been carried out by various research bodies in Kenya.

Since the beginnings of small farming systems research/extension in Kenya pioneered by CIMMYT in 1976, other research and extension bodies based in the Ministry of Agriculture, the Universities, particularly Egerton University, and Kenya Agricultural Research Institute (KARI) have been involved with research/extension on small farms in various parts of Kenya. This paper assesses the available information on small scale farms which have been influenced to some extent by small farming systems research and extension to determine changes in farm productivity. Recommendations have been made in the paper on improving the conduct of small farming systems research and extension in order to improve farm productivity on a sustainable basis in Kenya.

BRRI EXPERIENCE ON RESEARCH-EXTENSION LINKAGE IN SUSTAINING FARMERS' PARTICIPATION FOR INCREASING AGRICULTURAL PRODUCTIVITY <104

Nizam Uddin Ahmed

In the paper a brief description was given about how through site oriented cropping systems research in the Bangladesh Rice Research Institute (BRRI) from 1976 to 1980 using FSR/E methodologies, improved cropping patterns and management practices were identified and recommended for both rainfed and irrigated rice-based environments; then from 1982, multilocation tests of the recommended technologies within the extrapolation area were started by joint participation of the research, extension, and the farmers, which is still continuing and gained extreme popularity because of it's effectiveness in transferring the recommended technologies to the farmers and in increasing the agricultural productivity. A detailed description of the multilocation test methodologies adopted, results obtained across the years and locations in both rainfed and irrigated environments and how the refinements of the technologies made over time were discussed. Results indicated up to 60 to 75% increase in grain yield and net return in general for rainfed recommended technologies over farmers' existing practices. In the irrigated areas, the increase in yield and net return were in general about 25 to 50%.

Pilot production program (PPP) were undertaken in some areas where multilocation test was successful. At least in two such areas 2 to 3 years after PPP, assessment of the impact of FSR/E technologies on farmers' income, consumption and other expenditure patterns were made. A very brief note on the outcome of these studies were also given.

FARMING SYSTEMS RESEARCH/EXTENSION AND THE SMALL-SCALE AFRICAN FARMER <105

Samuel Asuming-Brempong

Five basic criteria were established for assessing the success of the Farming Systems Research as a means of developing and sustaining food production in the context of the small-scale farmer. These include:

a) the profitability of the technology involved under the production conditions of the farmer;
b) whether the approach recommended engages surplus labor and does not conflict with the production cycle or factor allocation patterns of the existing food crop production process which is the primary agricultural activity of the small farmer;
c) if market is established, and whether market conditions favor the small farmer;
d) how the new approach meets a primary goal within the household economy by providing cash income without threatening the household's ability to provide itself with staple foods; and
e) how easily accessible the recommended package is to the farming household.

A related issues also considers the effectiveness of extension in developing and maintaining farmer participation in the process of agricultural research and development.

A review of the impact of research on the small-scale food production in Africa was made. Farming Systems Research and Extension that focus on increased food production and sustainability in the African context has been discussed. Recommendations are made for enhancing the effectiveness of Farming Systems Research and Extension on the productivity of the small-scale farmer.

SIMULATION ANALYSIS IN FSR/E DIAGNOSIS AND PLANNING STAGES <106

Julio A. Berdegue, Michel Installe

INTRODUCTION

Dynamic analysis of farm data is at the core of the farming systems concept, whose definitions usually include the idea of many interacting components or subsystems.

Computer-based simulation and optimization models are being experimented as flexible and powerful instruments that can facilitate a multi-period, multi-objective, multi-component analysis of farming systems, and that can be incorporated into the FSR/E procedure.

The objective of this paper is to examine the benefits of simulation analysis, by presenting the results of one such exercise, utilizing the software GRANJAS. The paper explores the potential contributions of simulation models during the diagnosis and the design stages of FSR/E.

METHODS

GRANJAS is a fully interactive dynamic farm simulation software which runs on PC computers (MS-DOS) with at least 256 kB of memory. It consists of three integrated subprograms: a data manager, a model generator and a dynamic simulator.

The data manager works in a user-friendly, question-and-answer mode. It requests the user to provide a list of resources and activities that are or may be present in the farm, and the monthly amounts of those resources that are used, consumed and produced per unit level of each reported activity. Any type of resources and activities are accepted by the model, and they need not belong to any pre-specified category, thus providing maximum flexibility.

The model generator produces a mathematical model which consists of two equations, one which describes the amounts of resources, and a second one which describes the balance of usable resources. The model generator allows the user to select, from the data base, any given subset of activities and resources that he/she want to consider in the simulation, thus permitting either a whole-farm (all resources, all activities) analysis or a more specific exercise (e.g., only resources and activities related to animal production).

The dynamic simulator computes the amounts and balances of resources for each time-period, given an initial amount of resources, levels of activities and a definition of the time-period. Results are presented in various tables and displays.

This software was used to help in the diagnostic and planning stages of an FSR/E project being conducted in the province of Bio-Bio in Central-Southern Chile. The data bank was structured using information such as periodic farm records, and include 72 resources and 15 actual or potential activities; the objectives and restrictions of the scenarios incorporated the results of interviews with local farmers; the activities included both traditional technological alternatives and innovations that were being on-farm tested.

RESULTS

Four simulation scenarios were tested: the first one reproduced the production plan currently utilized by an average household; the second included activities that would emphasize crop-based farm development; the third was a mixed, crop and livestock pattern of farm development; and the fourth scenario was a fine-tuning to adjust for imbalances on the availability of land, labor, and capital.

Scenario one yielded a diagnosis of the main current bottle-necks: low yields in all crop and livestock activities; low expenses; moderate-low net family income; very low returns to land and labor of wheat and milk production; strong seasonal labor deficits; low use of available irrigated land, due to labor shortages; etc.

Scenario two included technological alternatives which substantially improved the physical productivity of labor and that had a favorable impact on both yields and total production. Net family income increased 78%, and there was a 113% use of the available irrigated land. However, labor constraints were significantly aggravated, and the labor-critical period extended from five (scenario 1) to seven months.

Scenario three emphasized forage, cattle and milk production as the main vehicles to make a better use of the available land resources, without aggravating the labor constraints. Net family income showed an increase of 50% with respect to scenario 1, and the livestock subsystem became the main source of that income. While cattle and milk production did show a reasonable land/labor adjustment, forage production would still generate significant labor deficits, although the critical period is reduced from five to four months and irrigated land use is increased to 115%.

The combined analysis of these scenarios led to the conclusion that full intensification in the use of available land resources (regardless of the crop or livestock orientation of the chosen activities), would result in severe family labor shortages during part of the agricultural year. A fourth scenario was developed to adjust to the constraints imposed by the available family labor, while trying to maximum land utilization. Such scenario results in a net family income which is 30% greater than that of scenario 1, a maximum use of family labor and a minimal use of hired labor, and 80% utilization of the irrigated land.

After several rounds of discussion with the local farmers and their organizations, the FSR/E project was oriented following the general pattern suggested by scenario 4, while still maintaining on-farm research to try to generated new alternatives to make scenarios 2 or 3 more feasible.

CONCLUSIONS

GRANJAS proved to be useful: (a) in structuring previous information and data in a well organized data base; (b) in detecting the impact of suggested innovations in terms of production and income results and of resource requirements; (c) in analyzing the relative roles of the different subsystems and farm components under different circumstances; (d) in identifying the constraints that would result from the application of new technologies, and ; (e) in substantially increasing the rapidity of calculations, thus allowing the analysis of a very large set of actual and potential activities, within the context of planning the course of an FSR/E project.

However, the use of this type of tool, while not requiring any special mathematical or computer training, does demand a great deal of knowledge, both qualitative and quantitative, of the farming systems, so that the data banks can be structured and, most important, so that common sense can prevail over the enhanced capacity to generate scenarios.

107> COWPEA AND CASSAVA IN SWINE RATIONS FOR SMALLHOLD FARMERS: CROP PRODUCTION AND FEEDING TRIALS

Arsenio Calub, Catherine De Luna, Amelia Gerpacio

The Philippine crop-animal systems research project conducted integrated feedgrain and root crop production with pig feeding trials in Cavite and Pangasinan provinces. The experimental production module was designed for a farmer to grow cowpea and root crop for one growing fattening pig in 120 days. Farmer cooperators planted cassava in Cavite in August 1987. Cowpea and sweet potato were planted in both Pangasinan and Cavite in November-December, 1987 after rice harvest. The crops were intended to produce enough grain and tubers to constitute 30 and 41% of pig ration. Actual cost of producing cowpea was $0.24/kg dry grain compared to $0.30/kg soybean oil meal as of May, 1988. Cassava or sweet potato production cost was $0.02/kg based on 13.5 t/ha yield and $0.07/kg dry matter.

A total of 12 farmer cooperators were involved: 6 in each location. Three in each location planted the crops for intervention feeding of cowpea and root crop. The other three farmers in each location fed usual slop feed or control.

Weanling pigs weighing 15-23 kg were bought from a common source in each location. The intervention ration consisted of the following %DM: cassava/sweet potato meal 40, cowpea meal 28, rice bran 2, commercial broiler mash 18, local fish meal 6, imported fish meal 0.3 and salt 0.4. Both root crop chips and cowpea were hammermilled prior to mixing. Feeding level was prescribed by the project.

At the end of the 120 day feeding, intervention pigs had 0.558 kg average daily gain (ADG) vs 0.300 for controls in Cavite. In Pangasinan, it was 0.468 and 0.313 kg ADG for intervention and controls respectively.

Net cash benefits were not substantially different at the end of the experiment by intervention pigs were sold at least 30 days ahead of controls.

SEASONALITY INFLUENCES ON VEGETABLE PRODUCTION IN SWAZILAND <108

Douglas M. Gama, Doyle W. Grenoble

Many human activities, especially in tropical and subtropical climates, follow seasonal patterns. Seasonality is inherent in systems used to produce food crops. Climatic factors, available food supply, labor allocation, energy utilization, and poverty are among the factors contributing to seasonal patterns of crop production. The application of irrigation water to crops removes some of the climatic factors which impose a seasonal pattern on production, however, seasonality patterns still remain. The availability, consumption, and importation of produce, prices (both paid and received), and the health and nutritional well-being of people are all influenced by seasonality of production.

Through information gathered at the start of the Cropping Systems Research and Extension Training Project in 1982, the seasonality of vegetable production and marketing in Swaziland became apparent. The major period of production is during the dry winter season, using irrigation. The production of maize, the staple food crop, takes preference over vegetables in the rainfed summer season. Other reasons for the limited summer production can be cited, ranging from a lack of money for purchasing inputs to limited available production information for summer. Prices paid for fresh vegetables in the summer are often double those paid for winter produce.

In response to the marked seasonality of vegetable production a program of research and extension for summer production was undertaken by the horticulture section at the Malkerns Research Station. A modified version of Farming Systems Research methodology, involving several stages, was followed. Alternative solutions explored during the design stage included methods to improve the profitability of summer production. Research with long-day onion is an example of the approach used. In Swaziland, short-day cultivars only are grown in winter and are commonly marketed from August through January. At other times of the year onions are imported. Initial studies were conducted at the research station to identify cultivars which would produce marketable bulbs in the summer. Acceptable cultivars were then tested in on-farm trials over three years, and interviews conducted with farmers showed that all farmers were satisfied with the cultivars and production methods used. Extension demonstration plots were then planted throughout the country in 1987/88.

Production costs associated with summer production were 22 percent greater than for winter, however, net profits were more than 55 percent greater for summer than for winter. Summer onions have gone from essentially no production in 1982 to a projected 30 hectares in 1989/90.

BIOTIC FACTORS LIMITING FARMING SYSTEM IN MID-HILLS OF NEPAL <109

Bishnu K. Gyawali

Agricultural production in the mid-hills of Nepal is limited by biological constraints. Some of these biological factors are; insects, diseases, weeds and rats. In some ecological areas these pests cause serious damage to the crops. High yielding varieties response to high dose of nitrogenous fertilizer. Increase in carbon and nitrogen (C:N) ratio tends to increase incidence of pest status.

Though 93.4 percent people of Nepal are engaged in agriculture. Mid-hills of Nepal is deficit in food grains. Agricultural productivity has not changed substantially mainly due to lack of irrigation, high yielding varieties, chemical fertilizer and pesticides. Share of these inputs to the deficit area of cropping system site is not only costly but also untimely. Transport network is poorly developed. Food grains are carried through animals on trackroads. Adaptation of improved technique by the farmer is low.

POTENTIALS OF N_2-FIXING TREES IN THE DEVELOPMENT OF SILVIPASTORALISM FOR SUSTAINABLE FODDER PRODUCTION IN THE SEMI-ARID NIGERIAN SAVANNAS <110

Aloy Igboanugo

Animal protein supply and other animal products in Nigeria, are to a large extent, dependent on the poor husbandry of the gregarious FulBe, Fulani and Bororo herdsmen, operating mainly in the Sudan and the Sahel savannas of the country. In Nigeria, planned rangelands for livestock production are virtually inexistant. Recurrent drought, coupled with population pressure and recent sharp increase in area of land under cultivation in the Nigerian savannas, have drastically reduced the population of the naturally occurring forage species, which hitherto, were freely available for grazing, with concomitant adverse impacts on livestock production. In recent times, the nomads, with their flocks and herds, trek several scores of kilometers more than was possible in the past, in search of scarce forage and sometimes, especially where livestock population is high, the stock wander into farmlands, with disastrous consequences which sometimes end with litigation. The stress, arising from increased long distance trekking, has led to a sharp reduction in the rate of weight gains of stocks. Forest plantations and reserves in these areas, now, form the largest expanse of grazing land units, where the nomads feel freer to drive their stock to feed on the understorey forage. However, these plantations were not initially planned for silvipastoralism and the forestry authorities sometimes discourage such encroachments. Besides, the plantations and reserves form a highly insignificant percentage of the available land area and therefore have very low carrying capacities. Except some scientific means of sustainable forage production that can readily be acceptable to the illiterate nomads are initiated, forage scarcity may get worse with time. Silvipastoralism is an obvious choice. This paper discourses the characteristics of the nitrogen-fixing, multipurpose savanna forage and non-forage tree species, capable of being used in reclaiming the abandoned arid sites and for afforesting the apparently unperturbed savanna farmlands as silvipastoral rangelands in different tree forage-annual forage-domestic animal combinations. This would lead to sustainable supply of forage, a sedentary way of life for these nomads, increased supply of animal products and profitability in cattle, sheep and goat industry in Nigeria.

ANIMAL TRACTION IN COMMUNAL ZIMBABWE, INSIGHTS AND INTERVATIONS <111

V. L. Prasad

The animal traction problems of communal (subsistence) farmers in Zimbabwe have been addressed in a phased FSR project. The ultimative objective of the study is to optimize draft power, given the constraints of communal farmers.

Phase I, an initial diagnostic survey of the communal farming households, apart from presenting a socio-economic profile, provided insight into the: critical role of draft animal in achieving timely agronomic practices and optimum yields; feed constraints during the dry period and wastage/improper use of legume stovers at kraals; and about the animal mix (oxen, cows and donkeys) used in traction.

The on-station component taken up as phase II focused on the nutritional constraints of draft oxen. The study showed that steers fed limited amounts of groundnut stover did significantly ($P < 0.05$) better in terms of body mass changes and ploughing performance than – the unsupplemented controls. The energy expenditure of steers (MJ/hr) at ploughing has been derived on the basis of 'work done' and 'distance travelled'.

A more detailed, discipline (Animal production) oriented survey constituted phase III. The number of animal hours at different tasks and their spread was recorded. The draft energy requirements per farm have been calculated using data from phase II. Accordingly

cost effective recommendations to manage the draft power, have been made.

Phase IV which is yet to be taken up purports to elicit farmer response to the recommendations. The present paper is concerned with the first three phases of research.

112> DIAGNOSIS AND IMPROVEMENT OF DAIRY ENTERPRISE IN FARMING SYSTEMS ON COSTAL AREA OF SANTA CATARINA, SOUTHERN BRAZIL

Milton Ramos

A wide range of enterprises carried out by small farms usually leads to a complex farming systems. In the costal area of Santa Catarina, southern Brazil, a significant dairy production, comes from these farming systems. Such farm enterprise play an important role on cash income source, on year-round labor use, on farm resources use and economic performance of the whole farming system. Based on farming system perspectives a project has been running. The main goal is to understand the real circumstances of the farming systems, especially dairy enterprise, focusing research opportunities and assessment of possible technological alternatives. A stratification according to criteria has identified an intermediate group selected to develop the project. Data from the first year diagnosis showed that 20 to 90 percent of total year-round labor, was used for dairy production, and its importance as cash income source, ranging from 15 to 100 percent of total cash income. This data shows possible great influence of dairying on the whole farming system sustainability.

The project has the main line of action based on the following stages of methodological approach and strategy:

- Farming system diagnosis - the tool used for understanding real circumstances of farming systems. It enables an identification of the limitations in the physio-biological and socio-economic environment and in the employed technology.
- Technological alternatives development - screening and developing technological alternatives focusing changes in key system variables rather than modeling the whole farming system and concentrating on the most important components of the dairy enterprise. The experimental procedure depends on the evaluated alternative, but in all cases of field work, on farm research methodology is used. Extension agent and farmer participation is advisable. Farmer judgement is an important parameter to be considered.
- Farming system interference - farming systems selected for this stage must be analyzed after a period of diagnosis. The interference process, with the focus on changes in the key dairy system variables, has been carried out by a research team using technological innovations or applying directly available technology. Modified systems are evaluated for a period of time and the results are compared to standard system.

113> DEVELOPING PRODUCTIVE AND SUSTAINABLE FARMING SYSTEMS IN THE SMALLHOLDER SECTOR OF SRI LANKA

Ravi Sangakkara

The agricultural sector of Sri Lanka is characterized by a plantation sector with a colonial past and peasant smallholder sector. While the former consists of well managed plantations, the latter contains food producing units, namely lowland rice fields and upland irrigated and rainfed annual cropping systems. In addition, some smallholder units, especially in the wet zone of the island contain perennial crops such as tea, rubber, coconut and spices.

The smallholder agricultural sector has been considered a vital component of the agricultural development plans of Sri Lanka. This is due to their role in alleviating unemployment and urban population pressures, along with increasing productivity of the crops to meet local food requirements and the export demand of specialty crops such as the spices.

The smallholder units of Sri Lanka, especially those producing food crops in the drier regions are subsistance farming units. They achieve very low levels of production under rainfed conditions, especially in the dry season. The farmers of these units adopt traditional methods of production, and the sustainability of these units is extremely low due to poor management of resources.

Farming systems research and extension programs carried out in different parts of the tropics and to a lesser extent in Sri Lanka has identified means of improving productivity of the subsistance smallholder units. Studies carried out not only show increased yields but provide guidelines for the development of sustainable systems. Thus, research on the adaptability of the proven systems have been carried out on selected farmer fields. In the perennial systems, plans are made to increase the productivity and profitability of the more marginal units.

This paper presents the role of farming systems research and extension in increasing the productivity and maintaining the sustainability of the smallholder systems of Sri Lanka. Examples of case studies carried out by the author on rice units, where interseasonal relay cropping is used and in rainfed upland systems where mixed, multiple and avenue cropping is used are presented. Other studies on the perennial sector such as smallholder tea, rubber, coconut and spice crop units are also presented. These examples highlight the usefulness of adopting the farming systems concept in developing productive smallholder units. In addition the role of extension is discussed especially in terms of surveys to determine farmer needs and the development of on-farm trials. Emphasis is placed on the possibilities of achieving viable, productive and sustainable farming systems in the smallholder units, which play a principle role in the agricultural sector of Sri Lanka.

114> FARMING SYSTEMS RESEARCH: ITS IMPACT ON SUSTAINABLE PRODUCTIVITY AND PROFITABILITY

R. A. Singh, K. C. John, D. M. Maurya, K. R. Tiwari

Proponents of Farming Systems Research has often claimed the failure of the orthodox agricultural research paradigm in addressing the emerging problems of diverse agro-ecological situations and the superiority of Farming Systems Research in ensuring appropriate technology generation through holistic, inter-disciplinary and location specific approaches. Most often these claims have remained as pious intentions and its implementation has become problematic. Still scarce is the evidence that the alternate paradigm can contribute to the development of stable and sustainable systems with higher productivity and profitability. More important, with the dwindling interest of donor agencies' in farming systems research, could it be sustained institutionally in developing countries. The present paper addresses itself on the role of farming systems research in sustaining productivity and profitability of agriculture in villages of eastern Uttar Pradesh, India.

The rainfed villages have high degree of ecological diversity within short distances. One could find pockets of contiguous area submerged with rain water for periods ranging from 3-6 months, thus making the arable land almost unsuitable for cultivation. Simultaneously, one would also find in the same village, area where crops have to undergo water stress due to non-availability of adequate moisture at various stages of life cycle depending upon the monsoon pattern. Farmers in such ecological context have evolved, through informal but time consuming experimentation enterprise-mix, selected suitable landraces and adapted agronomic practices contingent on the precipitation received during different months of south-west monsoon. The region is predominantly rice-based farming systems. Several distinct farming systems have been evolved by the farmers in each of the rice ecologies, viz. upland - favorable and unfavorable, shallow lowland, deep water and very deep water. The enterprise portfolio is characterized by low productivity but able to withstand the viccitudes of natural vagaries.

At Narendra Deva University of Agriculture & Technology,

Faizabad, since 1985, a farming systems research project sponsored by the Ford foundation is being implemented under the leadership of Dr. D.M. Maurya, Professor and Chairman, Department of Genetics and Plant Breeding.

The emergent FSR methodology has the following components: whole village concept, multiple choice, matching of advance lines with local landraces, resource-poor farmers as partners in screening of advanced lines under their own management practices, discernment of farmers' evaluation criteria through horizontal diffusion (farmer-to-farmer exchange and training), and self-revolving seed bank.

Several lines of rice developed for specific rice ecologies at experiment station were matched with local landraces and given to the volunteer farmers for screening. In the subsequent seasons, advanced lines of other crops like wheat, bengalgram, mustard, linseed, pigeon- pea, urdbean, mungbean, sunflower, jute, etc. were also provided to the farmers, to be screened under their farming systems context. It is argued that experiment on-station researchers would continue to be directed towards evolving component technologies. The on-farm research with a FSR perspective enables these components to be evaluated under the farming systems context. Thereby, the complementarity between on-station and on-farm research is established.

The paper describes the process of agro-ecological mapping and utilization of decision-tree analysis to document diversity in farming systems under high ecological risk condition. Instead of concentrating on the dominant farming systems, this allows researchers to address diverse needs of resource-poor farmers.

A comparative evaluation of on-station and on-farm research trial is carried out. The dissonance between the researchers' and farmers' evaluation criteria are deciphered by mapping the movement of advanced lines - inter-plot by the cooperating farmers to locate the respective ideal ecological niche in the subsequent season.

The stability properties of systems due to the interventions are analyzed in short-term perspective. Neofunctionalism approach focusing on systems properties that lead to homeostasis as well as the effects of particular components and disturbance of the behavior of the system, i.e., stability versus processual approach is employed to highlight the effects of both stabilizing and destabilizing processes due to FSR. The relationship between different connotations of stability viz., 'constancy', 'qualitative stability', 'quantitative stablity' and 'resilience' is also explored. Finally, policy implications of FSR in high risk regions and the impact assessment of the FSR is inferred.

PRODUCTIVITY AND PROFITABILITY: A CASE STUDY FROM KANDI (RAINFED) REGION OF PUNJAB <115

Surendra Singh, V. K. Mittal, R. S. Rana, M. P. Singh, R. Bakhshi

Productivity and profitability are intrinsically related in fact and in effect are results of the extent of farm mechanization or the level of modernization of agriculture in any farming region. A study was make in Kanki Region in the state of Punjab in India. The region is rainfed and undulating in the sub-mountain area. It occupies 9.5 per cent of the total area in the state, has medium to heavy textural soils and depends on natural precipitation varying from 570 to 1060mm for its irrigation needs. Wheat is a major crop of the region and is grown in rotation with maize. Gram and fodder crops are also raised.

The village surveyed under this study was a representative village from Kandi region and surveyed for two years during 1986-88. The village has 98 farming families divided into four categories marginal, small, medium and large based on land holding. More than 50% of the farming families belong to marginal category having land holding of less than 1 ha. The village has human population of 718 and area under cultivation was 137.2 ha.

The farmers used wide range of implements in crop cultivation. However, the owning of the farm implements was dependent on the economic condition of the farms and farm size. Farmers preferred to hire, borrow and share farm implements for various operations. The most of the implements used were indigenous type and bullock-drawn. The village lacked in improved implements such as seed drills, disc harrows and threshers. The use of farm implements, unlike high yielding varieties and fertilizers, does not directly contribute to yield, but a change in it may mean less drudgery of work and/or higher labor efficiency and reduces the operational time, thereby widen the range of uses to which an implement can be put to raise the rate of utilization of that implement.

It was notices during the survey that farmers responded quickly to the new implements given to them and use was very extensive. This brought more acreage under the cultivation. The cost of cultivation decreased leading towards the more profitability. Multiple regression analysis of results revealed that the use of machinery has significant effect on the output of crops. Its correlation with output of wheat, maize and gram was 0.70, 0.49 and 0.87 respectively.

The average yield of wheat, maize and gram was 1743, 1051 and 391 kg/ha which was below the average yield of the state of Punjab (3506, 1586 and 437 kg/ha respectively). Even with this yield level the energy ratio was 3.73 and benefit-cost ratio was 1.32. This can be further increased by reducing cost of cultivation if improved farm machinery is introduced and better farm machinery management system is applied.

OPTIMIZING ANIMAL PRODUCTION AND PROFITABILITY IN A SUSTAINABLE AGRICULTURAL SYSTEM <116

John K. Ward

World wide demand for animal products continues to increase and is predicted to greatly exceed availability by the year 2000. Population growth and per capita demand are expected to continue their upward trend.

Farming Systems Research designed to optimize animal and plant production is needed particularly in countries with a deficit of animal products. Research must take the indigenous animal species and breeds and improve them through selection, introduction of new genetic material and modification (if desirable) through advances in bio-technology.

Research data will be presented indicating that both plant strains and animal breeds likely have at least a 20% variation in many growth and efficiency traits. The effect of single versus multiple trait selection on over-all productivity must be considered. Systems research will need to evaluate the combined effects of selection on both plant and animal production.

The plant-animal interface has been addressed during the past decade through short-duration grazing. A positive animal response has been documented; however, long-term effects on plant specie composition and soil management concerns will vary with location and is being studied at the present time. Illustrations from the Nebraska Sandhills will be presented.

Sustaining agricultural production systems in a world needing more plant and animal food sources will be difficult. Land areas suitable only for grazing will need improved varieties and holistic management practices while crop production areas will need to produce optimal quantities of grains while seeking to improve crop residue quality.

The challenge for those involved in Farming Systems Research will be to develop a holistic management scheme to optimize plant-animal production. We must develop more efficient animals that are able to utilize improved plant genetics to produce animal products for an expanding population desirous of increasing animal product consumption. This must be accomplished so that all peoples on the earth can have adequate quantities of food with the desired amounts of plant-animal products produced through a sustainable system that allows for both productivity and profitability.

GLOBAL SESSION: THE ROLE OF FSR/E IN SUSTAINING FARMER PARTICIPATION IN AGRICULTURAL DEVELOPMENT

117> PLENARY ADDRESS: FARMER PARTICIPATION IN AGRICULTURAL DEVELOPMENT

Jacqueline Ashby
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118> HESSIAN FLY RESISTANT SOFT WHEAT AND NITROGEN APPLICATION: ON-FARM EVALUATION BY RESEARCHERS AND FARMERS IN THE ABDA AND CHAOUIA REGIONS OF SOUTH-WEST MOROCCO

H. Benaouda, S. Lhaloui, M. El Gharouss

From 40 to 100 percent of the soft wheat variety Nesma, traditionally used by farmers is infested each year by the hessian fly in the arid and semi-arid zones of Morocco. Hessian fly infestation and low soil fertility result in low average yield (650 kg/ha). The National Agronomic Research Institute (INRA) has released a hessian fly resistant variety of softwheat (Saada) developed through selection on station in the USA. INRA has also determined that 60 units of nitrogen per ha is the recommended level of fertilization for both wheat varieties. In 1988-89, a multi-disciplinary team evaluated the Negma and Saada varieties at two levels of fertilization (0 and 60 units of N per ha) on 20 farms in two research domains (Abda and Chaoula). These trials were conducted on farmers' fields, with their resources, and under their management. Only Saada seed and N fertilizer were provided. The farmers were encouraged to follow their traditional practices in all field operations, except fertilizer dressing, and to critically appraise the suggested technologies (Saada and N) with respect to their own (Nesma and no fertilizer).

Evaluation was performed by farmers on the following variables: emergence, tillers, plant height, spike appearance, resistance to frost, diseases, drought, lodging, grain and fodder yield, grain appearance, flower color, baking attributes, and bread taste.

Evaluation by INRA scientists was performed on the following variables: yield by components (spikes per m2, seeds per spike, weight per 1,000 seeds), yield by sampling, yield as reported by farmers, emergence, and percentage of plants infested by the hessian fly.

A modified stability analysis was performed for each region. Environmental coefficients were computed for each region, farm and treatment. Environmental coefficients were then regressed on yield for each treatment in each region. Stability analysis results corroborate those obtained on verification trials, managed by INRA scientists on farmers' fields during 1986-89.

119> COMPARING SMALL FARMER'S PRODUCTION CONDITIONS WITH THOSE AT THE RESEARCH STATION - POSSIBLE IMPLICATIONS FOR TRANSFERRING TECHNICAL PACKAGES TO RURAL AREAS

Dirk W. Bergen

In this paper, it is first tried to show possible differences between production conditions at the research station and in the farmer's field. We have taken the example of a classical research (knowing that attempts exist already to get closer to the farmer's production conditions at the research station itself), which is compared to the situation of a farmer in the Buyenzi, being one of the eleven natural regions in Burundi (Central Africa).

Differences between these two types of production conditions can indeed be enormous, as will be outlined in the paper. One of the important conclusions is therefore that it is very difficult to make a proposal to farmers which can easily be integrated in their farming system, if this system has not first been studied and understood. Moreover, without farming systems research, it seems very difficult to propose a sustainable solution to farmers:

- at the level of a technical package as a whole and
- at the level of the various components of this technical package.

This will be shown by analyzing the technical package for beans proposed by extension services in the same natural region (Buyenzi).

The purpose of this paper is to provoke, in order to feed the discussion on the subject. Therefore, we have note tried to soften possible differences between production conditions at the farmer's level and at the research station. On the contrary, they have sometimes been reinforced. Farmers will not participate if we cannot propose a sustainable solution which can be integrated in their system.

120> IS PARTICIPATION A REALISTIC PROPOSITION?: SOME EXPERIENCES FROM ZAMBIA

P.N. Gatter, Patrick M. Sikana

The paper concerns Adaptive Research Planning Teams (ARPTs) in northern Zambia, from the perspectives of 1. a full-time team rural sociologist; and 2. a university researcher attached to an ARPT during doctors-al field work.

Two major issues are addressed in the paper. First, the continuing debate about the role of sociology/anthropology within FSR; which leads on to considering, secondly, (on the basis of a sociological understanding of the social, political and historical context in which ARPTs are working) what the possibilities are for a truly participatory approach to such research, and where the problems lie.

In the first part of the paper we look at areas for possible improvement of FSR, through sensitization to social issues (leaving aside for the moment the institutional context). Drawing on experiences in particular surveys, we highlight the importance of understanding household dynamics in considering possible technical solutions to production problems, and how such an initial understanding cam provide a more relevant framework for subsequent quantitative data collection than the current practice of arbitrary economic surveys that require massive collection of data, most of which can prove unusable, or at least difficult to interpret. We also discuss the need to get a grasp of the place of agriculture in local political economy: who grows what, under which circumstances, and for what purposes? How are priorities accorded to different activities, and, importantly, what are the relationships between agricultural and non-agricultural activities? Such qualitative information, we argue, can help identify more precisely relevant groups for particular kinds of intervention (e.g. household, extended family, male or female individual producer) and improve the context for interpreting labor data (the current tendency is for priorities to be deduced from the quantity of time spent on different activities).

We issue a caveat, though, that it is dangerous to be over typological; often it is more instructive to see rural societies in terms of processes and strategies, rather than units (household etc.) and the right balance needs to be struck between ease of data collection and application (through recommendations) and the anthropological tendency toward getting as informed a view as possible of what is "really" happening on the ground.

The second part of the paper represents a more radical departure. Drawing on the wider context of his doctoral field work, Gatter argues that villagers nd the institutions of development may have fundamentally different views of the world, which lead them to construe "development" in different, even irreconcilable ways. A crucial issue in the northern Zambian context is that research

organizations with a largely "productionist" orientation toward agriculture are trying to work with matrilineally organized societies which (even accepting their involvement in the wider money economy) have a strong "distributionist" leaning. In other words, research teams tend to look at the production of resources, whilst local villagers are much more interested in how they are distributed; and their relationship with government institutions, from their point of view, comes down to making legitimate claims on resources, rather than learning how to produce in an idiom of "sustainability".

Sidaka takes up "productionism" and "distributionism" in a different sense, to argue that the relationship between rural people and government (of which FSR teams are seen as representatives) is to be seen as a political arena, and one in which the people have become the domesticific knowledge. The agenda is one that has existed since before independence in Zambia, and the paternalistic role of the state had been such that rural people have internalized their supposed intellectual and dependency on external agencies.

Thus, the relationship between village and government institution is a very ambivalent one from the villagers' viewpoint; on the one hand they have learnt to expect government support in terms of resources, and become reliant on them (e.g. for maize production). On the other, they are continually trying to avoid what they perceive as policing activities becoming measurable.

We conclude by suggesting that the idea of participatory research has little real currency in the current political and institutional setting of FSR, at least in Zambia. Participation, we argue, can only come about through emancipation of the small-scale farmer from object to subject of research; a subject playing an active role in deciding the course and content of on-farm programmes. For this to happen quite radical changes would be needed in the way research institutions work, in terms of a much more thorough decentralization of power.

ANALYSIS OF FARMING SYSTEMS OF SEMI-ARID COMMUNAL AREAS OF ZIMBABWE: CONSTRAINTS AND OPPORTUNITIES FOR SUSTAINABLE AGRICULTURE <121

Harsharn Singh Grewal, B. Flach, S. Fandohan, P. Caron
A.B. Salifu, C. Jackson

Field studies were conducted by a multidisciplinary team of International Course for Development Oriented Research in Agriculture (ICRA), Wageningen (Netherlands) during 1988 to study the farming systems being followed by the farmers and to know the constraints and opportunities for sustainable productivity of semi-arid communal areas of Zimbabwe. Methodology involves review of secondary data and reconnaissance survey by interviewing the key informers, old people, priests, policymakers and extension workers to get the qualitative information of physical and socio-economic environment and to select the target area. Informal survey and case studies were undertaken by interviewing the farmers (men and women) in selected villages of target area to have the deep understanding of farming systems and to know the inter- and intra-household strategies of farming which enabled the team to identify the constraints and opportunities for sustainable agriculture in the area. All the possible hypothesis and recommendations were discussed by organizing a workshop with the farmers to know their response and feedback.

Low and erratic rainfall resulting in periodic droughts, poor soil fertility and soil erosion were found to be major problems for sustainable production in the area. Furthermore small land holdings, lack of purchasing power of farmers, insufficient labor and draft power had been found to be the socio-economic constraints for stable production and had increased the inequitability problem. The opportunities like possibilities of water harvesting techniques e.g. building of dams, tanks, contour ridging, contour ploughing, tied ridging, pot holes, deep ploughing of loamy and clay soils before onset of rainfall, mulching and weeding at early stage have been discussed for higher sustainable productivity. Short duration drought resistant high yielding composite varieties of maize, sorghum and millets will be more appropriate for this drought-prone area as compared to long duration hybrids presently recommended for the area. Improvement in the local varieties of groundnut and cowpeas and introduction of other drought resistant leguminous crops like pigeon pea and black gram can possibly induce the farmers to grow these crops in rotation and in intercropping with cereals to overcome the risk of complete failure of crops and to maintain soil fertility. Line planting of crops instead of broadcasting can greatly reduce the labor problem at weeding. Minimum tillage in sandy soil would be helpful to overcome the draft and labor shortage. Keeping manure in deep pits instead of unroofed kraals would improve the efficiency of manure. Improving the loan facilities through Agricultural Finance Corporation particularly for poor farmers would induce the farmers to use fertilizers for stable production of crops. Creation of off-farm activities can be greatly helpful to small farmers to increase their income.

THE RICE WHEAT PATTERN IN THE NEPAL TERAI: ISSUES IN THE IDENTIFICATION AND DEFINITION OF SUSTAINABILITY PROBLEMS <122

L. W. Harrington, P. Hobbs, et al

The International Maize and Wheat Improvement Center (CIMMYT) and the International Rice Research Institute (IRRI) are developing, in cooperation with interested National Agricultural Research Systems (NARS) a collaborative research program on the rice-wheat pattern in South Asia. As an initial step in this collaborative research program, scientists from CIMMYT and IRRI joined with researchers from the National Agricultural Research Services Center (NARSC), Nepal, to study the rice-wheat pattern in Nepal's Terai. This paper reports on an exploratory diagnostic survey conducted jointly by NARSC, CIMMYT and IRRI in Rupandehi District, Nepal.

The survey had three major objectives: (a) understand local farming systems, including interactions between rice and wheat, and interactions between the rice-wheat pattern and other system activities; (b) identify and define near-term and longer-term (sustainability) problems, and understand the causes of each of these; (c) identify further research needs, including research needed to improve the definition of poorly-defined problems. "Problem definition" here refers to assessment of the productivity loss (broadly defined) and incidence of a problem, together with an understanding of its causes (including causes stemming from system interactions).

The survey was reasonably successful in defining near-term productivity problems. Some near-term problems were found to stem from negative interactions between rice and wheat (eg., late planting of wheat, caused by late rice harvest; waterlogging of wheat, partly caused by the plow-pan left over from the puddling of soil for rice; etc.). Other near-term problems were found to stem from interactions between the rice-wheat pattern and other system activities (eg., nutrient deficiencies, partly caused by a reduction in FYM application, in turn due to increased use of FYM for fuel to replace increasingly scarce firewood). This paper lists the various hypothesized near-term problems, along with the corresponding problem-cause diagrams.

The survey was less successful in clearly defining longer-term problems of sustainability (ie., problems in sustaining the productivity of the rice-wheat pattern). Some farmers (especially those who were recent beneficiaries of new irrigation infrastructure) felt that rice and wheat yields were increasing over time. Other farmers (those with longer experience with intensified cropping patterns) tended to disagree. It was found that productivity trends were difficult to measure, as changes in land quality, cropping patterns, and input use were confounded with changes in underlying resource productivity.

Hypothesized problems affecting the sustainability of rice and wheat productivity may be summarized as follows: "The productivity

of both rice and wheat are likely to decline over time, due to growing deficiencies of phosphate and other macronutrients; the build-up of pests and diseases, including nematodes and stemborer; and a build-up of problem weeds."

Proper definition of these hypothesized problems implies, for each problem: (a) measuring trends in productivity loss (b) estimating frequency and incidence; (c) identifying major chains of causes. Sources of information that will probably be needed to improve problem definition include long-term trials, monitoring of farmers' fields, special-purpose surveys to assess pest and weed incidence, further examination of secondary data, and further recourse to farmers' opinions and perceptions.

123> FARMERS AS PARTNERS IN TECHNOLOGY DEVELOPMENT: THE CASE OF RODENT CONTROL IN RICE IN THE PHILIPPINES

Melanda M. Hoque

One of the critical issues identified by social scientists as cause for the poor adoption of technologies is the lack of farmers' inputs in the development and evaluation of the technology. Rodent specialists are not exempted from this shortcoming.

The non-adoption of a developed rodent control technology in the seventies was later blamed on the extension workers, the farmers and the technology, which was perceived as difficult to use and hence, ineffective. This paper therefore, describes farmers' participation in the evaluation of two promising rodenticides against rodent pests in rice and the subsequent rat control strategy that resulted from the farmers' involvement.

Two separate area wide baiting trials conducted with the farmers in their 154-hectare ricefields showed good control as reflected by a significant increase in yields in the baited area. Feedback from the farmers regarding the rate control trials point to important aspects and the promise of adoption of the baiting techniques tested with them.

The paper also describes an improved rodent control strategy from information generated in the rodenticide trials. This is being tested in three strategic locations in the Philippines. The final output from this joint endeavour of researchers, extension workers and farmers is a location-tested, matured technology which eventually hope to lead to the technology's final adoption.

124> A FARMER PARTICIPATED RESEARCH CUM EXTENSION PROJECT: THE CASE IN IPM TECHNOLOGY GENERATION FOR MAJOR INSECT PESTS OF VEGETABLES IN CALUMBA, PHILIPPINES

Melanda H. Hoque, Candida B. Adalla

Farmer participation in technology generation is now regarded as essential component for ultimate utilization of any technology. The concepts and practice of integrated pest management (IPM) is a complex and often times a difficult idea for farmers to conceptualize, more so to put into actual practice.

The project highlights the methodology by which Calumba farmers were made aware and subsequently involved in the process of component technology generation for insect IPM on vegetables commonly planted in the village. Ultimately, the farmers fully participated in the verification of the IPM scheme until the technology is being slowly adopted.

One of the important components of IPM is knowing exactly when to apply the control, based primarily on the economic threshold level (ETL) of the pest. The IPM control strategy for the major insect pests affecting the commonly grown vegetables in the area proved applicable as shown by the data from two crop seasons.

Finally, results indicated that economic concerns such as pressures to produce extremely insect-free crops and the difficulties attendant to regular pest monitoring hinders the full acceptance and utilization of the IPM technology among vegetables growers in the village. Suggestions for improving the present technology are discussed in the text.

125> FSR CAN HELP TO DEFINE THE CONDITIONS FOR ENHANCED PARTICIPATION OF THE FARMERS IN THE PROCESS OF NATIONAL DEVELOPMENT: USING THE DATA OF AN INVESTIGATION IN THE KIRIMIRO REGION OF BURUNDI TO ACHIEVE THIS KIND OF ANALYSIS

Jean-Pierre Hubert

Burundi is a small landlocked country in Central Africa. The country's primary resources come from agricultural produces and most of people's occupation is traditionally related to agricultural production. The capital and other towns are not (yet) a important source of social and economic progress or problems. These features and their consequences, such as high transportation costs to import or export products, emphasize the need for a development strategy which is taking into account these local possibilities and constraints.

Farming systems research can help in searching a strong basis for development, for example by analyzing what the evolution of these systems could be in time and what kind of improvement and priorities are compulsory to insure rural development. Data from a survey conducted with 240 farmers in the Kirimiro natural region in the center of Burundi are used to achieve this type of analysis, in which the coffee cash crop was chosen as an indicator for the farm's economic status.

Multivariable analysis of 11 variables from this investigation highlighted 4 groups of farmers and made it possible to forecast what the evolution of their farming systems could be in the near future. By examining some other variables of the survey, it was also possible to point out priorities for regional and national development. These priorities help to propose the basis for a development strategy, in which the farming system becomes the most important vector for economic development through food and cash crop production.

Other activities such as banking services, insurances, medical supplies, extension services... aim to assist the agricultural production, which can be considered as the heart (probably the only one possible) of the development process in Burundi.

Finally, as a consequence of this rural development, small scale manufactures and other services can be born and accelerate economic development of the country.

126> FARMING SYSTEMS RESEARCH AND EXTENSION WITH FARMERS PARTICIPATION IN ANIMAL HUSBANDRY IN THE SENEGAL RIVER DELTA

Tourrand Jean-Francois, Gaye Moustapha

Located in the Sahelian zone and serving as an important grazing land due to the withdrawal of flood waters (which offers grazing opportunities during the dry season), the Senegal River Delta was traditionally oriented toward animal husbandry. By the mid sixties an extensive land management program took place with the development of irrigated agriculture as its main goal. This land development program combined with the negative effects of droughts which occurred in the late sixties had dramatically modified the agricultural environment in the Delta region with changes both in cropping system patterns and animal husbandry.

In 1983 the Senegalese AGricultural Research Institute (ISRA) initiated a research program on farming system in the Delta with three main goals:

- to analyze the recent production systems trend;
- to have a good understanding of current production systems functioning; and
- to provide useful information and appropriate technologies to agricultural policy makers and development agencies.

In addition to the presentation of the research findings on animal husbandry in the Delta, this paper puts an emphasis on farmers participation in the different steps of the research program. While less involved in the first stage where they were only questioned, they actively participated in the latter stages in the design of the research-development program conducted by the farming system team.

THE FARMERS PARTICIPATIVE TECHNOLOGY DEVELOPMENT AND EVALUATION AT THE FARMING SYSTEMS RESEARCH SITE, JAMALPUR, BANGLADESH <127

Mahbubur Rahman Khan, Habibur Rahman, Zainul Abedin

The problems of rural poverty is integrated and holistic in nature. The development services rendered here is fragmented, specialized and relatively independent on each other. Thus, right from the beginning there is a gap between the providers and the intended receiver of the services. The only way to minimize the gap is to ensure a coordinated effort which will lead to an improvement in the quality of life. In the context of faster development and transfer of Technology, an effective mechanism has been developed by the Bangladesh Agricultural Research Institute through on-farm trial, where farmers, researchers and extensionists work together. The Farming Systems Research Program creates a great scope to develop and evaluate the same under farmers systems.

Operational approaches in technology development:

At the beginning forty-three cropping patterns were identified through benchmark survey, out of them seven were selected on the basis of wider adoption. These patterns were studied under three land types and two hydrological conditions. The study involved alternate technology and improved management systems. The strategies for improvement was modification in the pattern without drastic changes in it. The investigations involved better management, improved varieties, use of optimum seed rates, etc. Also several new high yielding varieties were superimposed as treatments on the improved management systems in each season. The results of these trials were compared with the results obtained through monitoring of the farmers practices in similar pattern. The results indicated that the outstanding technologies spread up horizontally. The adoption status study revealed that adoption rate were higher when there were no extra investment. The Agriculture Extension personnel visited the experimental field from time to time. The problems identified in the field were discussed in a monthly meeting of research and extension personnel.

The limitations and risk identified during technology development phase:

(1) The market price of the commodities greatly influences the change of cropping pattern.
(2) In case of long term experiment change of land ownership create problems regarding cooperation.
(3) Experimental inputs should be given carefully otherwise there is chance of misuse.
(4) The reliability of information and data from cooperator depend on sincerity and honesty of the field worker.
(5) The loss of farmers confidence about a technology was very difficult to gain again.
(6) The farmers cooperation decreases with the increase of time if farmers are unable to understand what he is doing and why.
(7) The cooperator and non-cooperator farmers should be treated equally otherwise it will create conflict among them.

Operational approaches in technology evaluation:

The outstanding pattern was selected on the basis of higher yield, more economic return and a few or no additional investment. Three years study (technology development phase) indicated that the pattern was economically and technologically attractive to the farmers. Investigation on adoption status of the new technologies indicated 20% farmers of the locality already started adopting the improved pattern in their field. Considering all the plus point a multidisciplinary production program was taken up at the farming systems research site to evaluate the success and gap of the technology at adoption stage.

1. A detailed plan was prepared by the team leader.
2. A multidisciplinary organizational meeting was organized.
3. A production program action committee was formed.
4. A farmers motivational meeting were also organized.
5. A production block was finalized along with farmers list.
6. To evaluate the program a formal survey was conducted to know the level of production of the farmers.
7. A regular monitoring was being documented related to production program.
8. Crop cut and sampling were done at the time of harvest taking representative samples from each category of farmers.
9. A field day was organized just before harvesting of the crops where the farmers got scope to explain their problems. In the same forum non-cooperator farmers also become aware of the problems and prospect of the program.

The experiments indicated that technologies developed for the farmers have to be modified on the basis of their capability because all groups of farmers are unable to follow the same recommendation. The necessary steps for an effective process of participative technology were (a) development of class specific technology, (b) development of eco-specific technology, and (c) development of technology according to the need of the farmers. The technology refinement should be therefore, done keeping the above points in mind.

MODELLING AN AGRARIAN SYSTEM ON THE LOCAL SCALE AS A TOOL FOR ACHIEVING FARMER PARTICIPATION IN RURAL PLANNING <128

Sylvie Lardon, Christophe Albaladejo

A method is proposed to achieve effective participation of small-scale farmers in the technical elaboration of development proposals. This kind of participation is seldom contemplated by development programs, not even on an experimental basis in research projects, and it poses two main methodological problems.

First, development and research practices may be classified in two kinds of approaches. The first pay considerable attention to the psychological and sociological mechanisms of decision making and to techniques of group animation and negotiation allowing farmer participation in the definition of the main development objectives. The latter involve detailed studies on peasant technologies and on the logic of their implementation by a community or of development of the environment. Nevertheless these two complementary trends never meet. This means that peasant participation can only be considered when the main objectives of a development program are being defined. We propose to establish a method for analyzing peasant technologies which allows to introduce them as a basic feature in the dialogue between development services and peasants therefore allows peasants to shape a development project with their own know-how.

Secondly, the geographical level of participation for the basic farmer is the locality on which he has a (relative) economic and cultural control. Development and planning service however have to consider and to plan their operations at the regional level. We are therefore trying to detect regularities in the local mechanisms of development and implementation of a peasant technology. Our objective is to establish a method that is generally applicable at the level at which development and extension services operate.

In the first part our research objective is resented relatively to existing scientific literature. Examples of research-development programs in South Brazil, Argentina and Paraguay are analyzed.

Our research is part of a program carried out in collaboration with the Agricultural Ministry of the province of Misiones (North East Argentina) and with the Agricultural Research Institute of Argentina and the University of Social Anthropology of Misiones. An historical analysis of the development practices of the Misiones Administrative services places the methodological contribution of our work in relation to the evolution of the know-hoe of these very development service which are asking us to improve it.

The second part describes the basis of a modelling approach of a rural community (El Paraje Lujan) composed of a hundred families in Misiones. Modelling the technical organization of peasant communities allows to go beyond the contingencies of the local level by taking into account the great complexity and interactivity of the peasants' techniques.

The Lujan community, composed of tobacco and food crop growers on a spontaneous colonization front, is taken as an example because it presents two interesting methodological characteristics. First it is a young agrarian system whose genesis we are studying: we began studying this community five years ago, i.e. before the families, who were initially illegal land occupiers, organized themselves to claim for, and finally obtain, land titles. Secondly this locality has not yet benefited from development interventions and is therefore appropriate for experimenting of a new kind of relation between peasants and Development Services. This settlement situation is useful for analyzing functionings, assessing parameters and recording their role and effects.

Correspondence between crop patterns and labor force and other production means available on each farm are known by the survey. The main rules of crop location decisions (relatively to slop, soil quality, house location...) are studied on a survey base. In the modelling process, a first step involves the farm level and aims at establishing the crop patterns resulting from the objectives of each family and the characteristics of their farms (collected during the survey). A second stage concerns the whole community. The network of technical relationships between farms (exchange of work, animals, tools,...) is dependant on social and family proximities and on geographical proximities between families. A biometrical analysis allows to bring out the main rules concerning the creation of a network of technical relationships relative to socio-geographical factors and to the technical needs of each farming system in the locality. A third stage attempts to take into account the interdependencies between individual projects. This is done by simulating the development of a new network of technical relationships between farms which corresponds to a situation following the implementation of the projects of each family. Fort that simulation, we propose step-by-step modifications of the technical network observed in order to satisfy best the new requirements of each project.

The process of data collection during the survey and the basis of the model are described (rules, stages,...).

In the third part a proposal to insert this model within development practices is presented. It is not intended for simulating the behavior of an agrarian system in the office and to take decisions away from intervention sites. On the contrary it aims at encouraging the managers of development services to be more closely involved in and informed about their sites of intervention. It is a communication tool at the junction between the Development Services and the communities; its function is to advise and to facilitate negotiations for carrying out the development operation. Two of its functions are analyzed.

In the first place it is an internal communication tool for the peasant communities themselves. The model must help the peasants to better visualize the consequences of their projects, implemented with their technology, on their own farm and on their social and technical surroundings.

The organization and animation of this internal communication is fundamental for the consolidation of the community's social cohesion and consequently for the evolution of peasant technology.

In the second place, it is a tool for external communication which must create a genuine dialogue with the development structure. The model must translate the consequences of the projects into symbols that can be understood by illiterate farmers (drawings, maps with peasant criteria, landscape simulations,...). It must also be technically efficient and compatible with the technicians' knowledge. Finally a method must be available to planning services, enabling them to infer on a regional level, decisions which may have been considered for the local level. This part of the method is essential for planning services as it allows them to avoid the contingency of localities and its absence would invalidate any negotiation with peasant communities.

129> FSR/E, INDIGENOUS FSR/E, AND SUSTAINABILITY

Constance McCorkle

Farmers everywhere conduct FSR/E of their own. They seek out new ideas and technologies from credible sources and systematically test promising innovations using empirical methods – selecting field trial sites, varieties, and treatments according to their unique agroecological and socioeconomic situation; controlling for non-experimental variables; often running trials across several years; and monitoring, evaluating, and debating the results with their peers. In a very real sense, too, farmers conduct much of their own extension as members of multiple informal communication networks for exchanging agricultural information and experience.

Two of the most common reasons for sustainability failures in FSR/E projects are the inappropriateness of inflexible "technology packages" for a broad enough spectrum of farmers and the numerous shortcomings (in staffing, training, funding, supervision) of many developing countries' extension services. This paper argues that by directly coupling formal FSR methods and modern communication science with farmers' own adaptive research and information networks (i.e. indigenous FSR/E), agricultural development initiatives can achieve more broadly appropriate, credible, cost-effective, and hence sustainable results.

Based on field research in the Sahelian nation of Niger, indigenous FSR/E processes are illustrated from Nigerien farmers' experimentation with new millet varieties and innovative application of actual and potential channels for transfer of these and other technologies. Rich opportunities for successful R&E based on existing indigenous practices and communication patterns are also highlighted with examples from native techniques of insect, rodent, and stria control, chadouf irrigation, and forage utilization. Finally, practical mechanisms for linking formal R&E structures into indigenous FSR/E are outlined.

130> THE ROLE OF AGRICULTURAL LEADERS IN FARMER ASSOCIATION AND THE IMPLICATIONS TO AGRICULTURAL EXTENSION EDUCATION IN THAILAND

Pornchulee Nilvises

The purpose of the study was to describe the role of leadership and the need for leadership training of leaders of the Farmer Association in transferring new technologies to farmers in Thailand. The study identified demographic characteristics of Farmer Associations leaders, the leadership activities performed, the perceptions held regarding selected leadership concepts, and the need for leadership training. In addition the study compared leadership variables to selected demographic data.

The study population consisted of 510 leaders of the district Central Committee of the Farmer Associations in Thailand. A cluster random sampling method was used to select participants for the study. A total of 125 chairpersons and vice-chairpersons participated in the study.

A three-part questionnaire was developed and used to collect data pertinent to the study. Descriptive and inferential statistical procedures were used to analyze the data.

Major demographic findings of the study included the following:

respondents had a mean age of 54 years; nearly 41 percent had completed a fourth grade education, with 59 percent having education beyond this level; nearly 34 percent of the respondents had income from all sources of over 100.00 baht (1 US$ = 25 baht).

Coordinating activities with an extension agent in conducting the extension programs received the highest rating among the leadership activities performed, which indicated that there is a need for leadership training to carry out leadership activities. The respondents strongly supported the concept that there had to be a willingness to share power and prestige with other group members for groups to be effective. The respondents indicated that more education and training was needed in establishing rapport with government officials and other organizations. Respondents who were chairpersons indicated more activities, held stronger perceptions, and had a greater perceived need for leadership training that vice-chairpersons. Low-income respondents held more positive perceptions regarding leadership than high-income respondents.

BUT IS IT PARTICIPATION? THE DIMENSIONS AND CRITERIA OF PARTICIPATION <131

John Poutius

The participation of farmers in the agricultural research and development process is recognized as important by workers in development whether in the United States or other regions. A difficult point, however, is what is meant by participation. Farmer participation has many meanings, from a limited participation in the outcomes of a project to an empowered participant in the decisions and activities as well as the results of a research and development project. This paper develops an operational definition of participation and provides a tool to aid in the assessment of the actual level of farmer participation in a project.

Any farming systems research/extension project provides several possible stages for participation: planning, implementation, benefits/outcomes, and evaluations. Farmers can participate in any or all of these stages. Each stage is made up of a series of key decision or action points. Farmers may participate at each of these points. How that participation takes place occurs in a variety of dimensions that include: who participates; the level of influence or power of the participant; and the process of participation.

Each of these dimensions can be further refined and examined based on criteria that are critical to each dimension. For example, the process of participation can be assessed based on such criteria as the structure or pattern of participation, the scope of participation, the ability of participants to initiate action, the impetus for participation, and the effectiveness of participation. Consideration of these stages, dimensions, and criteria can lead to an operational definition of what participation means in terms of a given project.

The above paradigm of participation is used as the basis of a check list that will aid a project leader in assessing where and how participation is occurring and what changes can be made to sustain participation. Aspects of this paradigm of participation have been field tested in Massachusetts on an Extension project. Conclusions about the paradigm and its use in Massachusetts are also presented in the paper.

THE USE OF KNOWLEDGE NETWORKS WITHIN FARMING SYSTEMS RESEARCH AND EXTENSION <132

Peter Schuthof

Background of the Research

On April 11 and 12, 1988 I attended a workshop organized by ILEIA at Leusden, The Netherlands. The major aim of this workshop was to identify "Operational Approaches in Participative Technology Development in Sustainable Agriculture." One of the research questions formulated during this workshop was to trace and map knowledge networks, and to analyze their function and use in a sustainable development process. In August 1988 I went to Zimbabwe to conduct a research based on the formulated research question.

The research was the last obstacle in gaining a Master of Science Degree in Rural Development Sociology, at the Agricultural University of Wageningen, The Netherlands. For the research period I was supervised by a member of the Center of Applied Social Sciences at the University of Zimbabwe, and a member of the Department of Rural Extension and Adult Education of the Agricultural University of Wageningen.

Introduction

The research tries to give more insight in how rural people's knowledge is generated, developed and exchanged. Special attention was given to information exchange: with whom do farmers exchange information, can knowledge networks be mapped and traced? Pr simply said, how did the farmer get the knowledge she/he possesses, and with whom does she/he share this knowledge? The research concentrated further on the interface between different networks, for example between the network of farmers and the network of agricultural extensionists.

The methodology consisted of three parts: historical crop analysis, knowledge analysis and potential analysis. The first part: historical crop analysis, concentrated on topics like: how farming has changed the last generations; what problems the farmers face now; and the ideas and techniques farmers have already developed to cope with these problems.

The second part: knowledge analysis, was to gain insight in flow patterns of information, how networks were established and how information was channeled from one network to another. I asked farmer and other people who they turn to if they want to know something, and why other farmers do things differently.

The last part: potential analysis, tries to put knowledge networks in a larger analytical framework.

The task is not just to collect rural people's knowledge data, but to strengthen the foundations for participation of the rural people in the process of generating new technical knowledge. Some people in the rural areas tend to lack the confidence to engage in self-help activities. An appropriate Farming Systems Research and Extension can help to fulfill the conditions for participation of the rural people in their development process.

The Research

The research was conducted in a small chiefdom: Mola, in the Zambezi Valley in Zimbabwe. The people living in this area are Tonga, they were resettled in this area after the completion of the Kariba Dam in the 1950's.

Most farmers in Mola are subsistence farmers, producing two harvests during the agricultural season. The staple crops in the research area are maize, millet and sorghum. on the river banks people grow vegetables in small, fenced gardens which can easily be irrigated. Only a few farmers grow enough crops and vegetables to support their families, others have to supplement their daily meal with buying food or by gathering wild fruits and leaves.

Spirit inheritance is very important in the Tonga society. In the agricultural system the spirit of the rainmaker is an important one. The rainmaker can not only predict when the rains will start or how much rain can be expected. He also plays an important role in blessing seeds, eradicating plant diseases, and he know why wild animals attack people or eat their crops. The rainmaker hardly knows anything about plant physiology or plant diseases, he knows why stalk borers or locusts attack the field of this particular person. He can tell why the spirits of the ancestors are angry and cause the disease, or make the wild animals attack a person. The plant diseases or the behavior of the animals are caused by angry ancestors and are not the problems in itself. The rainmaker is a kind of intermediator between the spirits and the farmers, the farmers need the rainmaker because he possesses the capability to help them.

The introduction of Christianity in the 1960's resulted in a lot of changes in the Tonga community. Christians do not believe in the poser of ancestors. People who pass away go to heaven or hell, they have no influence on what is happening on earth, only God has.

Only a few years ago an agricultural extension worker was stationed in Mola. His main duties are: organizing the field-days, introducing new varieties and giving consultations. In case of plant disease he will identify the disease and recommend pesticides to overcome the problem. The extension worker is foremost visited by christians, like he is.

Conclusions

There is hardly any information exchange or other kind of communication between the rainmaker and the extension worker. Although both claim to know how plant diseases must be eradicated, each from their own point of view, they do not discuss their views.

The people do either consult the rainmaker or the extension worker. Nobody first visits the rainmaker and if success fails after that goes to the extension worker. A minority neither goes to the rainmaker nor to the extensionist, because they know how to solve the problems themselves, and believe the advice of the rainmaker or the extensionist will not benefit them. This network is foremost made up of farmers who have been outside the cheifdom, and have met different agricultural practices which they now introduce in Mola.

The description of knowledge network in Mola, makes clear that it is not realistic to talk about the farmers network and the extension network. The reality is too differentiated and fragmented, we have to keep this in mind when trying to link different networks.

If knowledge networks play an important role in the spread, accumulation and generation of knowledge, how can these networks be used in the development process?

Most development interventions make use of women groups, farmers groups, landless people etc., most of the members of these groups are selected on ascriptive criteria like age, religion, place of residence of the members. Farming Systems Research and Extension makes use of so called "recommendation domains" i.e. a set of farms which face comparable conditions and are characterized by a comparable "farming system". When a Farming System Research and Extension approach was used in Mola this would mean that Christians and non-Christians would be member of the same recommendation domain because they have comparable farming systems. When taking knowledge networks into account one can notice that these "comparable farming systems" are part of very different knowledge networks. What advice ought to be given in case of plant disease, would it be pesticides (extension worker) or offering beer to please ancestors (rainmaker)? Working only through the extension worker or rainmaker would automatically mean leave out a big group of farmers.

I have argued here that existing knowledge networks need to be taken into account when introducing new technologies or enhancing self-help activities. By studying and analyzing existing knowledge networks Farming Systems Research and Extension may better fit to the farmer's situation and therefore more likely to succeed.

GLOBAL SESSION: THE ROLE OF FSR/E IN SUSTAINING INSTITUTIONAL DEVELOPMENT

PLENARY ADDRESS: INSTITUTIONAL DEVELOPMENT

THE ROLE OF FARMING SYSTEMS IN SUSTAINING INSTITUTIONAL DEVELOPMENT <133

Obdulia F. Sison

The role of farming systems in sustaining institutional development is a complex and interwoven reciprocal relationship among farming people, institutions and the physical environment. As local institutions continue to respond to the needs of the people they serve, a farming system earns credits for its viability and operational soundness and vice versa. An attempt is made in this paper to reinforce this assumption by pointing out lessons of experience in FSR/E in the Philippines which are of consequence elsewhere in developing countries.

Science and technology are not the ready solutions to the conceptual and operational problems of FSR/E. There are other difficult issues to contend with which are social and behavioral in nature, i.e., social interaction and institutionalized working relationships among farm families and the farming community; the dissemination and utilization of FSR/E findings; the delivery of much needed extension services; and, national commitment in support of these, among others.

These observations point to a need for social scientists/researchers, farmers and extensionists to work together towards an interdisciplinary holistic orientation to on-farm FSR/E. Such FSR/E activities should empirically (1) identify and systematically document determinants of sustainable farming systems and institutional development; and, (2) evolve a methodological framework for determining a farming system's impact and cost effectiveness as these relate to small farmers development and the formulation of supportive national policies.

THE INTEGRATED FARMING SYSTEM DEVELOPMENT APPROACH: THE PHILIPPINE EXPERIENCE <134

Jaime Aristotle Alip

The priority of the present government is to improve the national economy through agricultural productivity and family income of the small farmers in support of the Comprehensive Agrarian Reform Program (CARP). The Land Bank of the Philippines (LBP) has been authorized to play a key role in the program through the expansion of its credit operations. Thus, the LBP has initiated the Integrated Farming System Approach and the Integrated Estate Development Program to assist the small farmers in their problems on farm management and decision-making.

The Integrated Farming Systems Approach was initiated in June 1987 to improve the lending and collection performance of the Land Bank of the Philippines. The approach regards the whole farm as a business unit and seeks to maximize farm probability by integrating the whole farm as a business unit and seeks to maximize probability by integrating farm and non-farm resources and activities. In effect, constraints to farm development are minimized, lending risks reduced and higher repayment on both production credit and land amortization assured.

Among the more significant features of the Integrated Farming Systems Approach are the following: (i) it places heavy emphasis on community organizations whereby the values and attitudes of farmers are transformed; (ii) its implementation requires a team whose members are specialists in particular fields; and (iii) it requires the active participation of farmers through their organizations in decision-making, project planning and implementation.

Results in the three pilot sites of the Integrated Farming System Approach situated in Integrated Estate Development Program areas in the provinces of Tarlac, Pamplona, and Nueva Ecija indicate that the project implementation was successful. In fact, farmers' organizations were strengthened and community organization framework for farm organizations was developed. Following the successful pilot testing of the IFSA, the LBP has adopted this approach to small farmer development as a matter of policy and has likewise adopted the community organization as a major component in strengthening the farmers' organization. The farmer-leaders trained under the project are now being tapped as community organizers/trainers in other Land Bank IEDP areas.

AGRICULTURAL DEVELOPMENT FOR THE POOR: AN ASSESSMENT OF THE FSR APPROACH IN INDIA <135

Aruna Bagchee

It is now well-recognized that despite the 'green revolution' in India's agricultural production, the problem of rural poverty has persisted.

In order to reach these resource-poor farmers, a great deal of interest has recently emerged in farming systems research as a counter to the limited scope seem to the HYV technology and the T&V extension system.

What are the different formulations of FSR/E and the implications of using this approach?

Despite some conceptual problems with regard to FSR, it would be a useful approach in the Indian context at present. In practical terms, how may an FSR/E approach be brought into the existing research and administrative structures. The paper is concerned with integrating the FSR approach in the on-going programmes and establishments in the country.

INNOVATION-BASED WORKING GROUPS FOR A COMMODITY RESEARCH PROGRAM <136

Chris Bartlett, Lianabo Simba, Kazumba Kassongo

For an FSR team working in a food-crop commodity research program in Zaire it was decided to eliminate diagnostic analyses of the farming systems by means of exploratory surveys because they were too costly and time-consuming. Instead priority types of innovations for growing each crop were identified on the basis of region-wide analyses by each specialist. FSR work was then concentrated on helping to specify these innovations, to identify how they should be used and in making recommendations for the use of a single priority innovation. Each group draws up a strategy to achieve its objective, formulates research proposals, assigns work to a specialist or group and reviews and reports its work together.

The general strategy followed by each group is:

1. to suggest specific forms of the innovation on the basis that they have characteristics likely to satisfy farmers' criteria.
2. to select amongst these innovations first under controlled conditions and using selected, measurable criteria and the by letting farmers make a final choice through tests on their farms.
3. to identify changes in farmers' practices which would complement the selected innovations.

Actual activities carried out by each group vary according to the type of innovation and the stage of its development but typically consist of some combination of the following:

1. Region-wide survey to identify farmers' criteria for selection of the innovation and to identify major variations in production conditions and practices.
2. Experiments to identify innovation characteristics likely to satisfy farmers' criteria under farm conditions.

3. Experiments to identify production conditions and practices which have differential effects on the performance of the innovations being compared.
4. Researcher-controlled experiments to make initial selection between large numbers of innovations.
5. On-farm tests by farmers, assessed by farmers.
6. Researcher-controlled experiments and on-farm tests to identify practices complementary to innovations.

At each stage input from the farm level and the contribution of several disciplines is essential.

In this way FSR is brought into on-station commodity research in contrast to the pattern often encountered of the creation of separate organizations for FSR. Working groups were initially formed for each of the following innovations: cassava varieties, maize varieties, grain legume varieties, lime applied to groundnuts and alley cropping.

137> THE SAMUHIK BHRAMAN: METHOD OF PRIORITIZING, MONITORING AND REPLANTING AGRICULTURAL RESEARCH IN NEPAL

Shyam Chand, David Gibbon

Researchers in Nepal have coined the Nepali term 'Samuhik Bhraman' (literally 'joint trek') to describe a type of rapid rural appraisal. The Samuhik Bhraman can be defined as an informal, interdisciplinary group study used to understand farmers' situations and problems, and then to formulate research priorities design, and replan research. The Samuhik Bhraman emphasizes interaction among technical specialists and farmers and draft report write up in the field.

This paper will describe two main types of Samuhik Bhraman; firstly, topical (related to some specific area of study, e.g. crops, soil fertility issues), and secondly the system study e.g. wheat farming system of a particular area.

One of the main objectives of the Samuhik Bhraman is to establish a working coordination between district and national level scientists, by bringing them into farmers' fields so that the actual needs of the farmers are better understood. This paper examines different methods of Rapid Rural Appraisal and how the Samuhik Bhraman differs from them. One of the advantages of the Samuhik Bhraman in the Nepalese context is that it is less time consuming (10-20 days including treks and draft report preparation).

The paper will focus on the different steps of the Samuhik Bhraman, e.g. brief review of past work on the area of study, development of objectives, checklists, the procedures of interviewing farmers and group interaction among participants and farmers.

The paper will also examine the value of this approach with examples from previous Samuhik Bhramans carried out by Pakhribas Agricultural Center (PAC) on potatoes, wheat and system studies an assessment of the suitability of this method for coordinating district and national level scientists and its effect on improving national programs will be given.

The final part of this paper will be devoted to providing guidelines for the improvement of present Samuhik Bhraman methodology based on the lessons learned over the past ten years.

138> INSTITUTIONAL DEVELOPMENT FOR PARTICIPATIVE ON-FARM RESEARCH IN FLOOD PRONE REGIONS OF EASTERN INDIA

Anil K. Gupta, R. K. Singh, D. M. Maurya, B. N. Singh

Methodological inadequacies in pursuing on-farm research in high risk environment like flood prone regions are being increasingly felt. The method evolved at IRRI and CIMMYT do not deal with the problems inherent in designing trials for regions with very high ecological heterogeneity. Definition of 'recommendation domain' or 'extra-pollution area' poses tremendous difficulty in absence of proper definition of 'ecological niches'. A method developed by Gupta (1986) while working with Bangladesh Agricultural Research Institute and in semi-arid regions of India (Gupta, 1981, 1984) is being modified to deal with these challenges.

Socio Ecological Paradigm (Gupta, 1981, 1985) provides a framework for linking space, season, sector and social stratification. The key steps are:

1. Ecological mapping.
2. Identification of niches which have evolved historically through interactions between climatic, edaphic and human factors.
3. Through manual descriminant analysis, the gypothesis are derived from the farmers for explaining contrasting features of land use, agronomic and other practices and levels of productivity. 4. The ecological maps and the hypothesis derived as above are shared with the farmers to generate their universe.
5. The experiments are designed to: (a) validate certain practices of farmers which are followed by a minority but are found intriguing or useful by the majority or at least a large number of farmers; (b) standardize certain risk adjustment practices such as increasing seed rate with delay in sowing time or receding moisture; (c) generate technological answer through farmers or scientists designed experiments. What is important here is that the trials are laid out only in those niches where farmers' best corresponding practices or yield levels exist. The contention is that if a technology was found better than the farmers' best, its chances of diffusion were maximized. Further, a technology also need be tried in the environment where farmers themselves would try their counterpart practice.
6. The result of the experiments are fed back to farmers in small groups. This again is a step forgotten in most methodologies.
7. The ecological maps of larger regions such as districts are also prepared through village level extension workers to identify potential niches where different technologies need to be tried.

Superimposition of different maps of crops, trees, livestocks, weeds, flood or drought probabilities, soil types, etc. reveal ecologically vulnerable as well as sustainable farming system boundaries. Methods for linking micro-level risk adjustments with macro level public policies are being developed further.

139> INFUSION/DIFFUSION PROCESSES TO IMPROVE TWO-WAY AGRICULTURAL COMMUNICATION

Daniel N. Hilleman, C.J. Kharapuwa

The Malawi (South East Africa) Agricultural Research and Extension Pilot Communication Project (MARE) focused on enhancing the existing organizational structure of the Ministry of Agriculture to promote better two-way communication among researchers, extension workers and smallholders to increase the productivity, quality of life and incomes of farmers. It addresses both institutional development and farmer participation issues.

The major organizational communication problem addressed is centralization and the top-down flow of agricultural information which limits the ability to develop specialized messages targeted to specific audiences in specific agronomic and climatic regions. This organizational structure also limits farmer participation in the message development process.

Organizational systems, as they increase in size and complexity over time, tend to grow more asymmetrical. The symmetry which once provided good audience linkage and contact is reduces or lost. Often the source or the destination of the messages is obscured, and message correction through feedback is delayed or lost. The MARE Pilot Communication Project has field tested a communication process designed to restore the symmetry and flow of two-way flow agricultural information.

Emphasis in this applied research has concentrated on opening traditional systems up to farmer, extension field staff and adaptive

research inputs through an infusion process.

Many previous international development communication programs have emphasized diffusion at the expense of the infusion process. Frequently, these communication efforts used feedback to modify messages, but there was often little or no audience input about whether the message was needed in the first place. Feedback was aimed at modification of messages, not of programs. Initial MARE project data suggests the communication process is improved if an information seeking "whether" report component is infused by the client system.

Infusion is a natural reciprocal of diffusion. Infusion is information-seeking behavior on the part of the communicator prior to message development while feedback and diffusion are parts of the information delivery process. Information seeking provides data for message development and precedes message development and delivery. The process under study investigates decentralized organizational development at the regional level which is participatory and cyclical rather than hierarchical and linear.

This communication project consists of studies at two levels: the organizational impact of the overall design (the communication system) and, specific communications studies to test strategies which complement the infusion and message development processes.

The overall methodology of the communication project was a quasi-experimental design with four experimental and two control groups at the extension planning area level. On-going data collection was in the mode of "action research" which placed equal emphasis on data collection and attainment of concrete development objectives. The research was both internal and external, but emphasis was placed on internal monitoring of organizational response to the infusion effort. This approach made possible the shifting and reevaluation of objectives during the process as they were influenced by events, without invalidating the process or stopping its flow.

Several types of before-after studies and on-going data collection are presented. They include a baseline survey of farmer inputs, extension field staff perceptions of organizational communication flow and adaptive research and subject matter specialist integration into the message development process. The development of a decentralized communication system to produce localized messages at the regional level is also presented.

Preliminary data indicates general acceptance of the concept by both government and farmers. Components of this action research effort are currently being diffused into additional Agricultural Development Divisions within Malawi for further testing and modification during the 1989-90 growing season.

INSTITUTIONAL FRAMEWORK, TECHNOLOGY GENERATION AND TRANSFER SYSTEMS FOR IMPROVING SMALL-HOLDER MAIZE BASED FARMING SYSTEMS AND A SUSTAINABLE FOOD PRODUCTION IN ZAMBIA <140

C. A. Njobvu

Farming Systems Research is one of the strategies adopted by the Zambian government to achieve its stated agricultural policy goals of increasing food production and greater income for small farm families. Lack of a strong institutional framework for technology generation and transfer system is regarded as the most important bottleneck hindering the efforts being made for improving the productivity of small-scale farming and sustainable agricultural production. this paper examines Zambia's attempts to create an institutional framework for technology generation and transfer system with a FSR perspective. The role of farming systems research team in linking research scientists with the extension services and the farming community in the process of technology generation and transfer is discussed, while the results of a study of small scale farming in Katete and Petauke in Eastern Province are presented to illustrate the need for a strong institutional support for improving small-scale farming. The paper concludes that the task of farming systems research must be seen not only as that of generating appropriate technologies for small farmers, but also to improve the linkages between research, extension, farmers on the one hand and input supply institutions on the other to enhance information flow between research and farmers on the one hand and input support system on the other, to facilitate technology adoption and agricultural development. It is emphasized as important step towards improving small holder farming systems and sustainable agricultural development.

ORGANIZATION AND MANAGEMENT OF LOCAL INSTITUTIONS FOR SUSTAINABILITY OF TRAINING AND VISIT EXTENSION PROGRAMS IN DEVELOPING COUNTRIES: A GLOBAL PERSPECTIVE <141

B. Rajasekaran, Robert A. Martin

Increasing the local institutional capacity in Training and Visit (T&V) systems is suggested as an urgent need for its sustainability. In this paper, an attempt is made to identify the causes for inadequate development of local institutional capacity and recommend possible strategies to strengthen local capacity building in such extension programs.

The local institutional structure of the T&V extension systems, which is represented by the village extension workers and contact farmers will be discussed in the paper. Hierarchical flow of technology from top to bottom was found to be one of the causes for inadequate institutional development. Though the agricultural research system has contributed significantly to the transfer of scientific knowledge to the T&V extension system, its support to build the local institutional capacity has been absent. Cases to illustrate the absence of such support from the research system is also explained.

An analysis of the operation of the T&V system in the latter part of this decade revealed that the village extension agents were diverted to administrative and non-field oriented activities which affected their institutional development. Further, the village extension agents were charged with responsibilities such as distribution of inputs as seeds and pesticides also impede their primary objective, namely, timely recommendation of technical messages. The neglect of the knowledge systems of local institutions and the lack of interest in motivating them would pose a serious problem to the viability of the T&V system, the entire operations of which depends on the strength of its local institutions.

Effective organization and management strategies for local institutional development are being emphasized as possible strategies with a goal to improve the sustainability of the present extension system. Allocation of resources to develop the capacity of already existing village extension agents would contribute to improve the building of the local institution and reduce the spending on the selection and recruitment of new extension agents. A specific case to explain the wastage of resources is presented. Encouraging participation of village extension agents in the action planning forums of the divisional agriculture unit is suggested. Representation from contact and non-contact farmers in these forums would also encourage acceptance of the plans from the local farming community. Developing action plans from the top and implementing it locally leads not only to the waste of human and financial resources but also results in the poor implementation of the project through T&V.

The sustainability of the T&V system depends on how well the local institutions are effectively organized and managed. The need for utilizing the local extension agents' knowledge, diversion of resources, increased support from the research system, reducing the imposition of non-field oriented responsibilities and elimination of targets and achievements for input distribution are shown to be very effective strategies towards fulfilling that goal.

142> INSTITUTION BUILDING THROUGH 'LATERAL LEARNING' AMONGST ON-FARM RESEARCH AND EXTENSION PROGRAMMES AT ND UNIVERSITY OF AGRICULTURE & TECHNOLOGY, FAIZABAD, INDIA

R. K. Singh, Anil K. Gupta, B. N. Singh, D. M. Maurya, Dixit, Yadava, Pandey, John

Various methodologies developed for On-farm Research and Extension developed at CGIAR centers use normative approach. It is assumed that interactions with the farmers take place in vacuum or without any historical basis. Indian Council of Agricultural Research (ICAR) had initiated a large number of programmes in last 20-30 years which involved work on farmers' fields such as ECF (Experiments on Cultivators' Fields), Lab to Land (technology transfer programme), ORP (Operations Research Programme), KVK (Krishi Vigyan Kendras - district level multi-disciplinary body of scientists), On-farm Rice Research, On-farm Oilseed Research, Operation Research Project for Water Management etc. Many of these programmes did become just technology demonstration rather than trial programme. But over the years, colleague scientists while interacting with the farmers' began recognizing the limitations of existing methods in flood prone regions. Director, Research at NDUAT, Faizabad aided by INdian Institute of Management, Ahmedabad initiated workshop aimed at 'lateral learning' (Gupta, 1986) i.e., learning from each other. Some of the early insights were shared in FSR Symposium, 1988. Further work in this regard is sought to be shared in this paper. The paper also summarizes the need for changes in national policies of each programme; documents evidence of experiments started at station on the basis of farmers' feedback; inventorizes the examples of indigenous knowledge of the farmers' collected through scientists and extension workers and finally provides a framework for further work. Separate papers are being submitted to describe each of this aspect in greater detail.

It is hoped that sustainability of Farming Systems Research in high risk regions requires continuous learning from the farmers' as well as each other. The study of organizational context which facilitates lateral learning has remained an under-studied subject. This paper thus also makes a contribution towards outlining further areas of research on organizational linkages. An important area of 'organizational learning' ignored in much of the FSR literature is particularly highlighted in the paper.

143> THE RAPID RURAL APPRAISAL: AN INNOVATION FOR INSTITUTIONAL STRENGTHENING AND COMMUNITY PARTICIPATION IN FSR/E

Pamela Edo Sullano

The Central Visayas Consortium for Integrated Regional Research and Development (CV-CIRRD), a tie-up of multi-sectoral institutions under the umbrella of the National Agriculture and Resources Research and Development System (NARRDS) of the nationally mandated Philippine Council for Agriculture, Forestry and Resources Research and Development (PCARRD) and borne from the research investments of a pilot project on resource management, the Central Visayas Regional Project - I, has one of its primary purpose:

- to pursue an integrated R&D program, especially for the watershed of Central Visayas, that is farmer-centered, resource-based and community managed via an iterative process that is multi-disciplinary, inter-institutional and goal-oriented with a farming systems perspective in order to improve the productivity and quality of life of the marginal upland farmers, forest occupants and municipal fishermen in the region.

An experiment itself on the viability of an inter-agency undertaking in both research operations and research utilization, the CV-CIRRD under its functional organization has a technical arm called the Research Core Group, an inter-agency and multi-disciplinary team of researchers, extensionists, economists and communicators who facilitate linkage between the regional policy-making bodies and the pilot barangay research satellite stations for a streamlined coordination on farming systems researches and to share available resources and expertise in the process.

One of the vital functions of the core group at the beginning was to assess current status in the selected barangays where conglomeration of farmers living in a contiguous area of the watershed will be organized to generate technologies and information through field researches.

Where most of the team members came from government agencies, assessment of a barangay was usually done through a census, a field visit or the more popular surveys of different durations. However, the core group was introduced to a relatively unknown topic of an
RRA - Rapid Rural Appraisal.

The RRA as introduced from a few varied institutions had quite some similarities and yet definite distinctions. References on the inherent subjects relative to RRA were gathered, studied, deliberated upon by both the policy-making body of the consortium, the core group and several resource persons who have had experiences in that area.

For a period of seven months, the RRA, as an integrated learning of the group, was conducted in one social forestry site and four hillyland agriculture areas of the four provinces of the region. In each of the RRA's, modifications were done one after the other as deemed important and necessary and from one site to another.

The Research Core Group became the vanguards of the process in the whole region. Team members coming from different technical line agencies, provincial government units, academic institutions transferred that knowledge to their own technical personnel with the end in view of the maximum utilization of the regional RRA that was developed. The experience initiated the interest that was drawn towards the farming systems research methodologies and evolved a capacitation process faster than expected.

On the other end, the RRA that was conducted in the five barangays created that certain process of farmer-participation from the beginning of the assessment to data analysis and to the crucial research or development intervention itself that has to be accomplished in that specific site. Farmers as a community assisted by the core group displayed their potential in the sound diagnosis of their own constraints and contributed to the vision setting of their own farming system - that system that sufficiently utilizes resources to meet the basic needs of the family.

The CV-CIRRD through the Research Core Group and with the devolution of a process in Farming Systems Research and Extension as the Rapid Rural Appraisal, has in effect facilitated regional institutional strengthening while simultaneously catalyzing community participation in the total R & D arena.

GLOBAL SESSION: THE ROLE OF FSR/E IN SUSTAINING ENVIRONMENTAL QUALITY

PLENARY ADDRESS: ENVIRONMENTAL QUALITY <144

Jeffrey Leonard

This report presents a summary of the work of the CGIAR's Sustainability Committee. The Committee has sought to build upon the findings of the TAC Report "Sustainable Agricultural Production: Implications for International Agricultural Research" (AGR/TAC: TAR/87/22 Rev. 2) presented at the Consultative Group Meeting in Berlin, Federal Republic of Germany, May 16-20, 1988.

Like the TAC Report, the Committee commenced its work with the assumption that much of the activity of the CGIAR Centers is already concerned with developing techniques that contribute to the introduction of sustainable agricultural systems. The underlying of poverty through increased food production, coupled with relentless increases in population and the individual centers keep an eye fixed on the horizon. Will techniques developed today be sufficient to meet tomorrow's needs; will they endure the test of time? These have always been crucial questions helping to guide the centers in planning their research agendas.

The Committee in the initial phases of its work has focused attention on the strategic questions related to the subject of sustainability:

-. Are the Centers doing enough?
- Is their research on sustainability addressing the most urgent and pressing problems?
- Is it an adjunct to existing research, or is a "sustainability perspective" infusing all research?
- Are there obvious gaps in the current work pertaining directly to the promotion of sustainable agriculture?
- Is there as much collaboration among IARCs as appears to be warranted by the cross-cutting nature of sustainability; for example, between commodity-, area-, natural resource-, and policy-based Centers where sustainability is a factor of the crop, the ecological setting, the level of resource management and the socioeconomic incentives that condition farmers' behaviors?
- Are there opportunity costs and other hidden trade-offs related to the fact that a growing portion of IARC research addresses long-term sustainability, as opposed to short-term production needs?
- Finally, what longer-term questions pertaining to overall CGIAR strategy and organization are raised by the sustainability issue?

IMPACT OF FARMING SYSTEMS RESEARCH IN IMPROVING ECOLOGICAL PARAMETERS: A CASE STUDY <145

Ravi Sangakkara, W. Witharama

The dryland of Sri Lanka are characterized by a wet season bringing approximately 1600 mm of rainfall over a period of four months and a distinct dry period, when little or no rain is available for arable rainfed agriculture. Thus farmers, especially those farming upland rainfed smallholder units face losses in the dry period due to harsh environmental conditions. In addition, inherent problems such as diminishing fertility of soils, excessive erosion, weeds and low yields along with secondary problems such as reduction of forest cover have a major impact on the productivity and sustainability of these units.

Amongst the many types of farming systems research carried out in the tropics, alley cropping has been identified as a viable alternative for dryland agriculture. This is due to the inherent ability of this system to increase productivity of lands and maintain sustainability over a long period of time. Thus, a case study was carried out in the dry regions of Sri Lanka to evaluate the ecological benefits of alley cropping when compared with traditions open farming conditions. The study encompassed both the dry and wet seasons and used crops that are commonly grown by the farmers to develop practical indices of its success as a readily adaptable farming systems program.

The environments in the study were an open tract, akin to traditional systems, and two alley cropped tracts which were terraced. The alleys were developed with fast growing leguminous species, namely Leucaena and Glyricidia. The food crops selected were maize, mung bean and cassava in the wet season and cowpea and sesame in the dry season. The branches of the alley crops were lopped and the leaf litter used as a mulch in the wet season. The results do not illustrate major differences in all tracts in the wet season. however, soil water retention was greater in the alley cropped tracts. The value of alley crops in enhancing environmental quality for sustained agricultural production is observed in the dry season. The adverse effects of high temperatures and low humidities observed in the open tract are reduced in the alley cropped tracts. Soil water retention is increased, and yields obtained in the alley cropped tracts are significantly greater than those of the open tract. In terms of secondary benefits, the data illustrates the role of alley crops in increasing organic matter of soils. In addition, the loppings produce a significant quantity of fuelwood, and the presence of trees especially in the dry season has a beneficial impact on the depleting forest cover. The results are thus discussed in terms of the environmental benefits accrued by alley cropping along with the ability of system to produce sustained high yields from units that traditional have given low yields and which have been abandoned after a few years.

THE MACAYA BIOSPHERE RESERVE: FARMING SYSTEMS AND SUSTAINABLE AGRICULTURE IN HAITI <146

Marilyn Swisher, Charles Woods, Paul Monaghan

The Pic Macaya watershed contributes to four major rivers in the La Hotte mountain range of southern Haiti. The montane cloud forest of Pic Macaya is an important region of biological diversity and contains many endemic species of flora and fauna. However, the region is also important for hundreds of impoverished resident families and for migrant farmers who live in the lower reaches of the watershed. The preservation of Pic Macaya, one of the last remaining forests in Haiti, had been planned through the creation of a national park, with a restrictive core area and buffer zone. The current Macaya Biosphere Reserve project will utilize a farming systems approach to agricultural development combined with an ecologically sound plan for natural resource use in order to conserve the fragile environment of the watershed. A strategy of sustainable agricultural interventions, soil stabilization, and agroforestry will assist local residents in managing the biosphere reserve.

The project is unique in its approach to farming systems research and development, both in the way data about the system and its residents was gathered and in the ultimate goal of a land management plan that emphasizes conservation. A biological inventory of Flora and fauna identified distinct ecosystems within the region which correspond to different use patterns by the farming population. The rapid appraisal was preceded by community study in which an anthropologist collected historical data and identified land use patterns among different socio-economic strata in the community. Partly because of the remoteness of the area, this "pre-sondeo" was necessary as the project lacked even basic socio-economic data on the residents and users of the Macaya environment. In addition to profiling the farming systems, the interdisciplinary team of the rapid appraisal expanded their objectives to gather data on the exploitation of and attitudes toward environmental resources. The project is also using remote sensing data to monitor changes in the ecology of the watershed.

The Macaya Biosphere Reserve will work closely with residents

and users of the region to incorporate current land use patterns within a framework of natural resource management. Once local residents perceive a real self-interest in a conservation strategy, and if that strategy provides them with an improved standard of living, they will become partners in the development process and eventual stewards of the region's natural resources. The project will ultimately request that the region surrounding Pic Macaya be officially recognized as a World Biosphere Reserve.

147 > A SYSTEMS ANALYSIS ON FARMING SYSTEMS OF LAGUNA LAKE WATERSHED: SOME IMPLICATIONS ON ENVIRONMENTAL SUSTAINABILITY

Jagadish Timsina

A systems analysis was done on the existing farming systems of the areas surrounding the Laguna lake of the Philippines. Secondary data (both published and unpublished) were the major source of analysis for this study. Besides, interviews with key informants as well as with some fishermen and crop and livestock farmers of the area were also conducted to support and/or confirm the secondary data. Study showed that a direct interaction exists between lake and watershed influencing both each other. Analysis of the systems properties (productivity, stability, sustainability, and equitability) of lake and watershed revealed that the lake and the watershed environments were greatly influenced by the activities performed within the lake and the watershed. Any farming activities in the watershed had great ecological and/or environmental effects on both the watershed as well as the lake. Similarly, any fishing activities in the lake had also such effects.

The systems analysis also showed that both the lake ecosystems and the watershed farming systems are important in sustaining the farmers' productivity and income. Farmers perceived that the balanced management of lake ecosystems and watershed farming systems is essential for sustaining the environmental quality. The study also demonstrated that the farmers' indigenous knowledge on balancing farming and fishing activities is important in achieving a sustainable farming systems and a high environmental quality. Finally, the paper identifies some research priorities, and suggests some recommendations and policy implications for the development of sustainable farming systems and for the maintenance of high environmental quality in the areas surrounded by Laguna lake.

148 > A BIOSPHERE RESERVE APPROACH TO DEVELOPING SUSTAINABLE AGRICULTURE AND PROTECTED ECOLOGY IN AN UPPER WATERSHED IN HAITI

Roy L. Voss, Paul E. Paryski, M. E. Swisher

Traditionally, agricultural assistance programs in developing countries have focused their attention on assisting individual farmers and groups of farmers on maintaining or increasing productivity on their own or collectively owned lands. Extension programs and research and development programs aimed at enhancing the local farmers economic outlook are well documented.

Conversely, natural resources program assistance has traditionally relied on financing attempts at isolation of ecologically important areas (natural parks, forest reserves, protected watershed, etc.) by either strict guardianship (protection by forest rangers, fencing, etc.) or removal of any threatening human populations (transmigration, land trades, etc.). Participation of local populations in these programs has been largely through paid labor contributions (tree planting programs, fence building, etc.) or payment in kind (food-for-work programs) that have no long term advantages.

With the recent advent of social forestry and agroforestry types of program assistance a more ideal program of local population participation has been achieved. These programs involve training local people in the importance of natural resources and give them vested interest in the work, but unfortunately are usually interventions that occur only after significant natural resources have already been lost and do not focus on the local populations within or adjacent to the few remaining ecologically important natural resource areas that do occur throughout the developing world.

In most situations the indigenous populations are poorer, more isolated and less educated than an external population that a specific project was designed to help. For example, watershed projects to protect lowland areas from floods and provide irrigation, development of reserve forests, etc. are usually not designed with the local people in mind. These people also usually receive considerably fewer benefits from projects while being asked to curtail or radically change their own options for social and economic growth, and in practice are actually being requested to subsidize the project!

The concept of the biosphere reserve integrates the concept of protecting and rehabilitating an ecologically important area with the social and economic development of the local populations most effected by the natural resources project. Initiated in 1971, the Man and the Biosphere (MAB) program has provided international attention to this concept and has developed guidelines for biosphere reserve development.

The biosphere reserve proposed for the Macaya National Park area encompasses the park and approximately 10000 ha of adjoining land and its resident population.

The Park was established in 1983 by presidential decree. It includes approximately 5500 ha. of high elevation (over 1600 meter) mountain cloud and wet forest and pine forest in the mountains of the southwestern peninsula of Haiti. It contains many rare and endangered endemic species of plants and animals and provides watershed catchment for nearly all of the arable agriculture land in southwestern Haiti.

The projected reserve consists of six zones or use areas. The core zone is the Macaya National Park itself and will be treated as a protected ecological area. It is surrounded in part by a forestry zone that is considered a traditional forest with some economic activity allowed. These two zones make up the forested watershed on land not suitable for any type of agricultural practice because of steep slopes, high elevation and erodible soils. Agriculture and agroforestry areas make up two additional zones while small areas of forest regeneration and special uses (wetlands, etc.) complete the zone list.

A rapid reconnaissance survey (SONDEO) was completed prior to project startup and determinations of suitable interventions were made with local people participating. Such project interventions as intensified crop production on suitable lands, improved kitchen gardens, agroforestry projects, livestock improvement programs, steep slope stabilization and reforestation projects have been initiated with the assistance of the local farm families. In addition, a local guide association for the Park has been established and local extension programs in agriculture and natural resources conservation have begun.

While small in scale, the success of this project demonstrates the crucial needs in a truly integrated project of sustained agriculture and natural resource development. That is, recognition of the local population to the needs of the ecology, knowledgeable intervention in farming systems and natural resource management and most important to the local communities, a voice in and benefits from the imposition of a project.

GLOBAL SESSION: SPECIAL TOPICS

DRY SEASON FARMING AS A SURVIVAL STRATEGY IN THE SEMI-ARID PARTS OF GHANA: A STUDY OF THE BAWKU DISTRICT <149

M. Sulemana Abudulai

The purpose of the paper is to examine the role of dry season onion farming as a survival strategy adopted by farmers in the Bawku District of the Upper East Region of Ghana. The analysis demonstrates the increasing importance of this activity in an area otherwise devoid of non-agricultural income earning opportunities during the lean season.

The District lies in the Sudanic climatic zone immediately to the south of the Sahel and is located in the semi-arid north eastern corner of the country. According to the 1984 Population Census, the District contained 315,605 people over 85% of them live in remote rural settlements. Abject poverty continues to pose problems for policy makers, with households and people in this peripheral part of Ghana, (geographically, politically, in absolute agricultural potential) faring worse in relation to production and access to services, quite apart from having to deal with a hostile agro-climatic environment. Despite their significant contribution to the achievement of development goals of self-reliance, improved nutrition, reduction of poverty and increased food security, farmers in the area have found themselves marginalized in agricultural development programmes and strategies. Evidence of the area's underdevelopment is also supported by the fact that it has the highest rate of malnutrition and infant mortality and the lowest rates of life expectancy in the country. The paucity in social and economic infrastructure is manifest in inadequate levels of health, educational, transportation, marketing, storage, and agricultural support services. Seasonal unemployment in the District has resulted in high rates of out migration to the more 'affluent' parts of southern Ghana.

Like other semi-arid parts of West Africa, the District is one of marked dry-seasonality, where persistent drought and ecological degradation continues to affect the precarious sources of income of people. For the great majority of rural inhabitants whose livelihood depends on farming, the lean season is the most difficult time of the year when food shortages, high food prices, diseases, malnutrition and infant mortality become rife. Food processing, trading and other economic activities undertaken by women play a vital role in providing most families with sustenance during the prolonged dry season. Kade, Nafkolgu, Binduri, Tilli, Garu, and other parts of the Bawku District, dry season vegetable farming, particularly that of onions and tomatoes has emerged as an important economic lifeline.

Onion farming originated in the early part of the century when demand was found to be high in the expanding urban centers of northern and southern Ghana. The initial impetus was also found in the construction of several dams in this area during the colonial and immediate post-independence period. It has since emerged as a mechanism of adjustment to unfavorable economic, social and agro-climatic conditions.

The study, (which was part of a broader investigation of agriculture in the Bawku District), centered on Bugre and Kuka, villages located about 9 miles from Bawku town and which have a long tradition in the cultivation of onions. Preliminary investigations carried out indicated that the Bugre dam provided a means for the cultivation of onions and other vegetables throughout the year over an area of 2 square miles involving around 200 farmers. A random selection of 35 farmers (17.5% of the estimated total) was selected on the basis of the plot layout near the dam. Most of them also cultivated onions and vegetables in the river valley close to the village. This was taken into account in the estimation of the total area under cultivation. Data was sought on farming techniques, access to labor, land and other inputs, output, economic returns and the importance of this activity in the household, village and regional economies.

It was found that involvement in onion farming depends to a large extent on access to irrigated or valley land. The availability of fertile low-lying land in dry river valleys and depressions as well as near dams has enabled large numbers of families in these villages to cultivate specialized crops like onions, tomatoes and leaf vegetables during the lean season.

This paper shows that onion growing has been developed entirely by the villages with little assistance from public sector support service institutions.

Although hired labor is sometimes used for land preparation and weeding, over 85% of farmers rely on mutual assistance arrangements. It also highlights the vital role played by women in transplanting, watering, harvesting and marketing operations, and shows how technical, social, economic and ecological factors combine to produce highly flexible patterns of operational holdings.

It examines marketing strategies adopted by farmers in an area characterized by poor transportation facilities and severe fluctuation in producer prices. Seasonal fluctuations in prices and returns reflect variations in supply, while intra-seasonal price ranges are a result of poor access to lucrative markets.

The significance of the high returns to most onion farmers is examined in relation to their ability to meet food and other financial needs throughout the year, and especially during the lean season.

Despite the great potential shown by onion and other dry season farming activities, this innovation continues to receive little assistance from government and NGO support; rather greater emphasis continues to be placed on main seasons farming activities.

SHOULD RICE PRODUCTION IN BANGLADESH BE RECONCILED WITH OTHER CROPS? <150

Kamaluddin Ahmad

In Bangladesh, rice is the most important crop as well as the main staple food. The other crops, favored by congenial agro-ecological conditions, include potatoes, vegetables, fruits, pulses, oilseeds, spices, jute, sugarcane, tea, tobacco, betel leaves and betelnuts. A strong bias exists for rice so that four-fifths of the country's cultivated land are engaged in its production. The overwhelming leaning on rice is also apparent from the 'food first' attitude of small farmers who constitute the vast majority of the farming community. Such attitude is reflected also by the nation's general anxiety for producing and eating more rice. The institutional efforts for crop-production in the service domains of irrigation, improved seeds and pesticides and the general areas of research, extension and policy-planning are all tuned mainly to the requirement of rice.

This paper examines closely the objectives of the country's agricultural programmes which, according to the Second Five-year Plan, are : self-sufficiency in food; improvement of nutritional standards; expansion of export and import-substitution crop; increased productivity; improved marketing and distribution; development and conservation of natural resources; rural developments nd generation of remunerative and productive employment. The analysis reveals that the rice bias not only failed to benefit the country, but also acted as an impediment to the fulfillment of the cherished goals. It finds that the agricultural development targets of the Third Five-year Plan that the country has embarked on tend to continue to lean heavily on the production of rice, since most of the natural resources like land, water, manpower and other production inputs have been set aside for this crop.

This paper advocates a more realistic understanding of the whole issue. The bias for rice should be done away with, keeping in mind the nutritional and socio-economic aspects of the matter, as well as the limited availability of the natural resources of land and water and the necessity of conserving them for the days to come. The paper has asked for a reconciliation between the production of rice and that of other crops--perhaps the most essential and urgent approach

needed for the much-desired self-sufficiency of both food and nutrition, and the concomitant conservation and generation of employment and income for farmers at large.

Toward fulfilling the country's needs, the paper suggests the consideration of a good number of measures (with due recognition of the importance of rice). These include emphasis on the production of wheat as the second staple food crop, compromise between rice and other crops in relation to the use of inputs with special emphasis on giving an optimal share of water to both rice and non-rice crops; promotion of potato as the third staple food; and massive crop-diversification efforts leading to manifold increase in the production of several non-rice.

151 > FARMING SYSTEMS RESEARCH/EXTENSION APPROACH FOR LATHYRISM VICTIMS

Mohammad Akanda, M. Hamid, Islam Mollah

With the lowest per capita arable land in the world and application of a primitive agricultural production technology, Bangladesh is constantly faced with the problem of feeding its burgeoning population. The food deficit is particularly characterized by the shortage of essential animal sources of protein. The production of food legumes, which are often called poor man's meat, have also been constantly declining due to the expansion of calorie-rich crops namely, the cereals, rice in particular reference to protein, is deteriorating.

Out of the major six or seven pulse crops, Lathyrus (*Lathyrus sativus L.*) is the most important since it account for one-third of the area under pulses and their production in Bangladesh. Two other important attributes of Lathyrus are its ability to grow under flood and drought prone conditions and its potentials as a rich fodder crop. All these attributes are, however, shadowed by the presence of a serious neurotoxin present in the grain which when ingested for a prolonged period may lead to an irreversible paralytic disease called Lathyrism. The fact that Lathyrism is localized in two locations of Bangladesh, though Lathyrus is cultivated and consumed all over the country, has attracted the attention of medical, agricultural, and social scientists.

Lathyrism in human beings is a non-reversible neuron degeneration of lower limbs with symptoms similar to lateral sclerosis in the chronic stages. Onset of the paralytic stroke may be acute, subacute or insidious depending perhaps on the amount of neurotoxin consumed by eating the seeds of *Lathyrus sativus*. The victim may suddenly feel weak and heavy in the legs and loins with tremulous muscles when weight is put on them. Legs have to be dragged with increased effort and impaired ability to walk. In mild cases only ankle knee joint movements are restricted by muscle spasms, forcing the victim to walk rigidly on the balls of his tilting movements of pelvis. Patients with advanced symptoms walk with a characteristic scissoring gait needing a single or two sticks for support. The serious cases are compelled to crawl. ARms are not involved and other movements are normal.

Lathyrism is considered to be a poverty associated disease since poorer landless people in rural areas are more susceptible. Several factors may lead to this disease, the most important being the continued consumption of Lathyrus grain as a staple in an undercooked form. The disease occurred in Europe, North Africa, the Middle East, Afghanistan, Russia and India. Major epidemics have been reported from France, Algiers, Russia, India and Spain. In recent years, Lathyrism has been restricted to North Central India, Ethiopia and Bangladesh.

This study was done to identify the factors associated with the production and consumption of Lathyrus in two sites of Bangladesh, and to design and test FSR technologies in the selected areas. Data were collected from the secondary and primary sources. Secondary data were mainly collected from the Bangladesh Bureau of Statistics. Primary data were collected by means of field survey. Analysis of food habits of Lathyrism victims in comparison to the unaffected individuals within and among the households was done.

The study showed that the composition of affected and unaffected families with respect to religion, sex-ratio and age is similar and does not account for the incidence of Lathyrism in the affected families. The proportion of earning vs non-earning members of affected and unaffected households is not different. Agriculture is the primary occupation of affected as well as unaffected households. Lathyrism has affected the marital status of affected population. Affected households earn substantially less that the unaffected households. The affected households had similar and relatively poorer quality living accommodation. Lathyrism affected families consumed more of the produce themselves than the unaffected families. Marketing of Lathyrus is not uniform throughout the year. The relationship between landholding classes and the incidence of Lathyrism is neutral. Males are more susceptible to Lathyrism than females. Lathyrism strike suddenly without any prior symptoms. Lathyrism strikes during the peak periods of consumption of Lathyrus. More than half of the patients who sought treatments for Lathyrism did not show any improvement. More than 80 percent of the Lathyrism patients are engaged in non-agricultural labor and some handicraft work. Landless and small farmers consume more Lathyrus than larger farmers. Male adult member of the family consume more Lathyrus than the females, older members of the family and children.

Since Lathyrus has an important place in the cropping patterns of Bangladesh, the more pragmatic policy would be developed for the affected areas. The study indicated that there is a great scope for farming systems research to find alternative suitable technologies for the areas.

152 > APPLIED COMMUNICATIONS TECHNOLOGY AT CIP: RELAYING AGRICULTURAL RESEARCH AND DEVELOPMENT INFORMATION

Carlos Alvarez, Carmen Siri, Douglas Norton

This paper documents an approach used at the International Potato Center (CIP) to identify, characterize, and implement technologies of information transfer related to potato and sweet potato research and development. The primary objective is to develop a common conceptual and operational framework that can link institutional management and operational roles at CIP. A multidisciplinary team is helping to design the diagnostic tools and to plan and implement the new technologies that link farmers and institutions at national, regional, and international levels.

This systems approach draws from modern management theory, CIP's "Farmer-Back-to-Farmer" model, and an agricultural information-supply model adapted from Lionberger. Discussion centers on previously undocumented connecting patterns that are being reshaped by modern communications technology. The related communications descriptors are defined in terms of communications skills; facilities and equipment; operational roles. Special emphasis is on patterns and processes that traditionally are discussed as communications-media design, creation, exchange, distribution, and evaluation.

A concluding section examines some of the quality-control and validity concerns inherent in more diverse and rapid electronic information generation and delivery, when not accompanied by appropriate review and documentation.

153 > CONTRADICTORY DEVELOPMENTS IN FOOD SECURITY IN ZIMBABWE'S COMMUNAL AREAS

Nick Amin

After nine years of political independence and the establishment of majority rule and despite the implementation of a land resettlement program, Zimbabwe's agrarian sector has continued to retain most of the features of structural disarticulation which characterized the pre-independence period. Widely divergent production systems

and commoditization patterns separate the two main agrarian sub-sectors, namely, the peasant sector (now known in Zimbabwe as the communal areas and the capitalist sector (known as the large scale commercial farming sector). In the immediate years preceding independence the peasant sector's share of maize (the main staple crop) sales to the domestic market (which was, and still is, largely controlled by the Grain Marketing Board, GMB) tended to fluctuate around 7%. Notwithstanding the fact that there has been no major land reform the peasant sector's performance, measured in terms of its share of domestic production and marketed output for two commodities, maize and cotton, has been significant over the post-independence period. Thus the annual maize intake of the GMB from the peasant sector leaped from 8% in 1980-1 to 35% in 1986-7. In the context of the much publicized African agrarian crisis this change in Zimbabwe represents something of a "success" story.

The positive contribution of the peasant sector to national food self-sufficience levels since 1980 is undisputed. In fact, Zimbabwe has on several occasions exported maize to several of its neighboring countries during the past few years. Although national food self-sufficiency levels have been maintained at a high level, implying that Zimbabwe may not therefore have a serious food security problem, evidence actually points to the contrary, in particular, that food insecurity in the rural areas (including the peasant sector) continued to be seriously high.

Evidence of malnutrition among the rural population casts doubt on the generality of the impact of the recent production and marketing success in the peasant sector.

This paper will examine the factors which explain the dramatic rise in the peasant sector's share of national marketed maize. Secondly, it will examine the extent to which the widely reported success has been a broad based phenomenon in the peasant areas. Drawing on the results of an on-going survey of households in two communal areas of Zimbabwe the paper will focus on contradictory dimensions of the food question and argue that more fundamental policy changes will be required to solve persisting problems of rural food insecurity.

IMPACT OF ECONOMIC CRISIS, ADJUSTMENT ON URBAN RURAL < 154 RESOURCE FLOWS AND FOOD PRODUCTION IN DIVO, RCI

Elizabeth Annan-Yao

A) La Commission Nationale d'Installation des Jeunes Agriculteurs Modernes (CNIJAM)

The economic crisis of the early 1980's and the excessive drought of 1983-84 increased the already existing rural-urban migrations, emptying the rural areas of their valid workers and overcrowding the towns. This situation is worsened by increasing unemployment especially among school-leavers, loss of jobs etc. As a result of all these factors, town dwellers will swell from 47.3% in 1985, to 55% in 1990 and to more than 67% in the year 2000. To check population explosion in towns, to keep young farmers on their land, to ensure relief of ageing farmers so that agricultural production will not suffer and finally to absorb youth unemployment overburdening the towns, the Ivorian Government set up in 1988, the CNIJAM, headed politically by Minister of State III, Alliali. Its permanent Secretary is the Minister of Agriculture. The main aim of this commission is to install youth on farms with modern equipments absolutely necessary for technological improvement in agriculture. However, apart from the pilot test program set up in Yamoussoukro and which involves 300 youth exploiting food production on 1500 hectares of land, the commission has not really started work. It has only set up Departmental and Sous-Prefectorial committees composed of local authorities whose job is to register all youth willing to farm and also to inventory all fallows available whether they have owners or not. The situation we encountered last summer in Divo remains unchanged: inscription of youth wishing to "return to the land" done in July last year still awaits reply (see our Mid Term Report).

It is obvious that Divo is "le grenier (storehouse) de la Cote d'Ivoire" which justifies our choice of the area for research on promotion of food production. However, both initial field work and actual field research show that the national reorientation of return to the land in this region has remained a lip-service. Officials of the CNIJAM (Ministry of Agriculture) say that the Yamoussoukro Pilot Test Program will be extended to Bouake, the East and North only. Divo is not included in the project and this means that the youth in Divo will have to fend for itself and seek its assistance from elsewhere - something it has not yet understood. Some of those I interviewed mistook me for a government official sent to fund and launch large scale and high yield farms. While it is clear that several youngsters, especially those without access to land, expect government assistance and solutions and are therefore idle, others are trying hard and are managing on their own. There is no organized structure (governmental or private) regrouping the young farmers returned to the land in Divo. but they all belong to the Association des Jeunes Agricultuers Modernes de Cote d''Ivoire (AJAMCI) created last February in Divo during a national seminar uniting youth returned to the land from all regions of the country. Those in Divo are scattered all over the "Prefecture" but I decided to interview about 50 youth in Divo "Sous-Prefecture", basing my choice fundamentally on the ethnic variable: equal amount of Dida, of Ivorian immigrants (Akan, Dioula, etc.) and of non-Ivorian immigrants (mossi, Maliens, etc.). It is important to note that Divo's fertile land has been attracting immigrants since the beginning of the century and is now attracting young Dida wishing to return to the land.

B) Youth (people aged between 18 and 45 which conforms with the February Seminar proposition) in the field at Divo.

1) Access. My recent field-work revealed several categories of young farmers between the ages of 20 (Dida) and 42 (Baoule, so far the oldest). Access to land is a crucial problem in Divo. Land ownership is characterized by 3 conflicting elements: ownership to those bringing unoccupied land into production; official rights to land (modern law); traditional rights to land (customary law). It is interesting to note that all the Ivorian youth I have so far interviewed inherited their land from their father. Immigrants (Ivorian and non-Ivorian) fathers had bought their land from Dida landlords before World War II. One Burkinabe was still renting his land from the Dida though. The sizes of land vary considerably from 2.5 hectares (young Dida) to 35 hectares (Baoule). My actual findings show that immigrants are more motivated than the local Dida and have more land. Naturally, the former do several labor migrations and have specific interest in farming and so settle down to it.

Even some young Dida who have also effected several labor migrations are found to be more motivated than their counterparts who stayed put. However, Didas are always faced with land scarcity problem and cannot therefore extend their fields.

2) Control. The non-Ivorian immigrants (e.g. Burkinabe) renting land have only limited control over it because their access to their land is temporary and can be lost at anytime. If some Didas are taking away their land from non-Ivorian immigrants to give to youth returning to land, others still prefer to rent them at higher prices and therefore change tenants (see our Mid Term Report). Even the Akan immigrants (Baoule, NZima) who inherited land from their father might be faced later with problems not from Dida but from other members of their extended family claiming their customary rights to the same land. This was the case of one NZima respondent who was sued for inheriting his father's land but won the case because of modern law. Anyway, the fact that these Akan have emigrated from their original milieu certainly lessens such conflicting situations in Didaland and most of them are able to control their land and use it as they wish.

3) Use of Resources. Our hypothesis that surplus food crop production is positively related to farm size and coffee/cocoa

revenue is confirmed in Divo because big landlords (rich farmers) always manage to increase their export crop revenues through food production. They have hired labor, make use of inputs, receive financial help from urban relatives (urban-rural resource flow) and generally have no commercialization problem. The small landholders (poor, new farmers), on the other land, consecrate themselves only to food crops. They can neither afford hired labor nor inputs and only depend on agricultural advice (SODEPALM) to obtain high yields in their food crop production. They are faced with the problems of commercialization because of overproduction during harvest time. Most of them would like to do counterseason farming but have not the means to purchase the necessary equipments like water pumps, creation of barrages etc. in this category are several young Didas who could do with external assistance since their folks are too poor to help them.

Tentative Conclusions.

Divo has quite a number of motivated youth who have returned to the land and are determined to set a good example so other school leavers will be attracted. This could be a means of absorbing youth unemployment, of relieving aged farmers and of increasing food production if only external aid can be sought to help install more youngsters on farms.

155 > CLASSIFICATION AND TYPIFICATION OF FARMING SYSTEMS USING MUTLIVARIATE ANALYSIS

Julio Berdegue, Octavio Sotomayor, Cristian Zilleruelo

INTRODUCTION

The homogenous target groups or areas is a key activity in the FSR/E approach, it being a methodology that is site- and/or group-specific. A number of concepts and procedures have been designed to facilitate this task, ranging from quantitative studies to more qualitative rapid surveys. Also, different types of variables have been emphasized, leading to agroecological, socio-economical, productive or problem-oriented groupings of the target entities.

Multivariate analysis techniques, available in micro-computer statistical software, can facilitate the task of classifying and characterizing different types of farming systems, producers and/or areas coexisting within the population of interest.

This paper deals with methodological issues involving the use and place of multivariate analysis within the FSR/E procedure and theoretical framework.

METHODOLOGY

The research leading to this paper was conducted in the province of Nuble, in Central-Southern Chile. This province was chosen because of its significant contribution to national agricultural production, and because of the large relative importance of small-scale agriculture within it (9,000 peasant farms). In addition,mm it presents -form the purposes of this paper- the advantages of comprising a very large area (approximately 10,000 km'), and of being very heterogenous in terms of types of farming systems, agricultural orientations, and agroecological conditions.

A formal survey was conducted using a province-wide sample, stratified over agroecological zones. Data was obtained for variables related to family structure, land tenure, land quality, use of labor (on- and off-farm), crop structures, agricultural outputs, livestock, capital availability, agricultural equipment and infrastructure, relationship to markets, income and income composition, administrative and farm management practices, access to technical and financial assistance, and technology used in the main crops.

These data were analyzed using Cluster Analysis (CA), Principal Components Analysis (PCA) and Discriminant Analysis (DA). Also, conventional statistical procedures (descriptive statistics, correlations and regressions, chi square and others) were applied when needed. All analyses were done using, simultaneously, a large number of variables, representative of phenomena of differing nature. The basic purpose of this work was to identify and characterize homogeneous types of farming systems, in order to select research householdfarms and areas and clarify target populations.

Since the sample size had been calculated so that it would be representative of the populations of peasant farms of both the province and of the main agroecological zones, the above-mentioned types of multivariate analyses were conducted at those two levels, in order to compare the results of these procedures when working with homogeneous or heterogeneous entities.

RESULTS

1. A procedure for the statistical analysis of the data was established, that started with CA to generate basic groupings of farms, followed by PCA to interpret the results at the level of general tendencies affecting each group, and ending with conventional statistical analysis by each of the extracted principal components, to describe each group according to the variables included in the survey. DA was utilized to generate a parallel classification to check, using the chi square statistic, the stability of the resulting classes of farming systems. This was found to be a procedure that made an adequate use of the strengths of each type of analysis.

2. At the whole-province level, two kinds of arming system types were found. A first kind included types of systems that cut across agricultural and crop/livestock structures and orientations, and that were determined mainly because of the strong influence of socio-economic characteristics. A second kind included systems that were strongly determined by a specific crop or group of crops.

In addition, at this level of analysis it was found that there was a strong positive correlation between the degree of farming system diversity and the strength of agroecological determinants: zones with harsher agroecological conditions included only one or a few types of farming systems, while more benevolent areas were also the more heterogeneous in terms of farming system types.

3. At the agroecological zone-level, it was found that in the harsher areas (remote, rain-fed, low-quality soils) the analysis tended to yield groups that represented variations of a basic archetype of farming system, while in the better quality areas (irrigated, well communicated, good to excellent soils), the resulting groups represented largely different farming system types.

4. PCA yielded groups of phenomena (factors) that were interpreted to be the essential expressions of the forces which induce a given type of peasant agriculture: the degree to which irrigation is available, share-cropping and land tenure, off-farm labor, and the market, infrastructure and agroindustrial consequences of sugarbeet, rice or wine-grape production. Thus, this analysis provided an understanding of peasant agriculture which goes beyond the farm-level.

5. Descriptions are available for each of the groups found at each of the two levels.

CONCLUSIONS

1. Multivariate analysis was found to be a rapid, powerful, and easy-to-use method to identify and characterize homogeneous farming system types.

2. The results obtained in this study allowed an efficient selection of research and target areas and provided a degree of understanding of macro-factors that would be expressed at the farm-level and that need to be considered in the following phases of the FSR/E procedure.

3. The descriptive analysis of each type yielded a detailed diagnosis of the structure, functioning and problems at the farm-level, that permitted moving towards a first stage of on-farm research at a faster pace than it would have been possible otherwise.

4. The comparison of the results at the province- and agroecol-

ogical zone-level, was useful n obtaining a clear picture of peasant agriculture in the area, thus providing a broader framework for understanding farm-level systems and guiding on-farm research.

WORKING WITH IRRIGATION DOMAINS IN FARMING SYSTEMS "A FRAME OF REFERENCE" <156

Harold Capener

Irrigation systems have traditionally been designed, built, operated and managed by engineers and those trained in the physical and natural sciences. These specialists have an affinity for working with structures and water resources because the challenges of irrigation naturally derive from their scientific and professional fields.

There is common agreement on the purposes for which the irrigation schemes are built–to provide a reliable, adequate and equitable supply of water from the land. These multiple purposes automatically expand the spheres of influence and responsibility beyond the engineering and natural sciences to successfully accomplish these purposes.

The reality of this expanded perception is portrayed which identifies three domains of typical irrigation scheme. The first domain is the source or the watershed where water is captured and stored. This leads to the second domain or the water supply and conveyance system. The third domain is the agricultural sector representing the end purpose for which irrigation schemes are designed, namely to increase agricultural productivity. Removal of excess water is also a requisite in this domain.

In analyzing these three descriptive domains, the importance of the supporting institutional, financial nd production aspects within each domain as well as the social, economic and environmental features are recognized.

Engineering successes are well documented in the construction of major dams, reservoirs and storage facilities along with sophisticated conveyance and supply systems. These represent the first two domains. These successes, however, have not been matched int he third domain--agriculture. Benefits from current levels of on-farm water management have fallen far short of projections in terms of increases in agricultural productivity, equity and income distribution and safeguarding the environment in areas such as waterlogging and salinization.

In analyzing traditional irrigation development policy, it is apparent that priority attention has been given to the watershed and water supply domains. Responsibility for efficient utilization of the water below the supply outlet is frequently shifted to others, i.e. to agricultural departments and to farmers.

In large measure, a serious system level break occurs between the second and third domains. Consequently, as population pressures have increased and concerns for national food self sufficiency and rising prices for food imports have occurred, policy analysts are seriously examining why there continues to be shortfalls in overall agricultural production.

A unifying frame of reference that helps tie the three irrigation domains together is the notion that water flows through four distinct "disciplinary systems." These are the (1) physical, (2) agronomic, (3) economic and (4) social-cultural systems. The broader analytic framework that these four "systems" provide, also creates a more wholistic perspective allowing a better fit for all aspects of irrigation schemes. The analytic and functional realities of each of these disciplinary systems is described in detail.

Two separate but parallel program approaches have evolved in recent years (1) On Farm Water Management usually associated with ministries of irrigation and (2) Farming Systems Research and Extension usually associated with ministries of agriculture. The striking similarities between these two approaches are examined.

Irrigation schemes have been planned, designed, constructed, operated and managed with a heavy orientation toward engineering solutions to a series of otherwise complex problems related to increasing agricultural productivity. Evolving experience suggests that the more an interdisciplinary perspective is employed in conceptualizing and implementing the dynamic nature of irrigation schemes, the more effective and efficient will be their overall operation and management leading to increased agricultural productivity.

Specialization and bureaucratization are relentless in denying collaborative relationships between ministries, departments and disciplines. Fortunately a counter movement is gaining strong support which holds that infinitely greater success will be achieved in developing and implementing programs when there is full participation of beneficiaries. The "participatory" philosophies of improved On-Farm Water Management and Farming Systems Research and Extension are gaining steady support. Public and private sector technical and professional staff, and the farmers and farmers' groups within specific irrigation schemes, can and should join forces to improve their irrigation system in order to provide a reliable, adequate and equitable supply of water to increase agricultural productivity. The descriptive and analytical approaches proposed.

GENERACION DE TECNOLOGIAS EN MAIZ BAJO CONDICIONES CERO LABRANZA <157

Romulo Ing. Carrillo

A COMPREHENSIVE APPROACH TO THE INTRODUCTION AND DEVELOPMENT OF A CASH CROP IN A SUSTAINABLE FARMING SYSTEM IN BURUNDI <158

Amal K. Chatterjee

In the rain fed farming system practiced on the hills of the Karuzi province of Burundi, the farmers depend on extensive use of manual labor in every aspect of the crop production from seeding to harvesting resulting in labor constraints at certain peak periods. Therefore a comprehensive approach was used in the SFSR project to ease all aspects of crop production in order to increase the productivity with the single most important step of testing a new cash crop, ie. upland rice and introduction of a new thresher and a new experimental grain blower to process the harvest.

Five upland rice varieties from IRRI, Philippines were tested and screened for their eventual adaptability under purely rainfed conditions of north eastern Burundi where the potential for a cash crop like upland rice is though to be great.

In addition a simple portable rice thresher made of wood was fabricated to facilitate the threshing of not only the upland rice but lowland rice as well keeping in mind the low cost of such equipment because of low resource base of subsistance farmers.

Lastly a simple mechanical grain blower based on an IRRI model was locally made to facilitate the grain cleaning operation with a view to adapt the machine for other crops like sorghum and corn.

METHODOLOGIES FOR STRUCTURAL AND FUNCTIONAL ANALYSIS OF THE FARMING SYSTEMS APPLIED ON THE MUGAMBA-REGION IN BURUNDI <159

Luc D'Haese

In order to study the dynamics of the farming systems it is necessary to examine the structural and functional situation of the farm.

The "menu", proposed by the regional projects, for innovations are identical of each farmer. These differences are related to the natural demographic and socio-economic conditions in which the farmer has to operate. These factors define homogeneous sub-regions within the natural zone.

The total area available, the age of the farmer, the existence of salarial revenue etc...help us to define the types of farms. The

analysis are done on the basis of statistical methods such as principal components, discriminant analysis, cluster analysis and the basis of a pragmatic approach. These last method give the best result to explain the possible dynamics of the farming system.

160> METHODOLOGIES FOR LEARNING ABOUT GENDER AND FARMING SYSTEMS RESEARCH

Hilary Feldstein, Susan Poats, Janice Jiggins, Doyle Baker
Barbara Grandin, Patricia Ladipo

The development of acceptable and sustainable agricultural technology depends on a high degree of farmer participation in identifying constraints, potential solutions, trial design and implementation, and evaluation. Such participation should include men and women who are involved with and have specialized knowledge in different parts of the whole farm system. This year's panel on methodologies for applying intra-household and gender analysis to FSR/E will include practitioners who have developed techniques which maximize the use of local knowledge and farmer participation.

FORMAT: The four presenters will address three questions:

1. a short description of their methods as used in the field;
2. how the use of the methodology improved research or extension; and
3. how farmer participation in technology development has been encouraged or sustained.

PRESENTERS: Dr. Barbara Grandin, International Laboratory for Research on Animal Disease -- technique for wealth indexing as a means of stratifying samples and learning about local concepts of ranking and resources for agricultural production; Dr. Patricia Ladipo, Senior Lecturer, Department of Agricultural Extension and Rural Sociology, University if Ife, Nigeria -- determining preferences for new maize varieties through laboratory testing, market surveys, and economic analysis focusing on post-harvest uses; Dr. Doyle Baker, IITA, Senior Agricultural Economist, National Cereals Research Extension Project, Cameroon -- use of farmer groups for on-farm trials and extension in Botswana. The fourth presenter is yet to be selected. The panel will be organized and moderated by Hilary S. Feldstein.

161> THE ROLE OF FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E) IN PROMOTING SUSTAINABLE FOOD SYSTEMS

Timothy R. Frankenberger, Kathleen DeWalt, Patricia O'Brien-Place

Agricultural development efforts cannot be considered successful if they fail to physically sustain the target population. Current efforts to create sustainable agricultural development have also reinforced the need to approach projects from a perspective that emphasizes the protection and enhancement of household food security as a primary concern for sustainability. Two reasons can be cited as to why this concern should be addressed. First, consumption goals of farmers may act as constraints to the adoption of technology and these constraints are usually not recognized. Such constraints include the need on the part of farmers to protect family food supplies; competition for household labor among maintenance activities such as food processing, preparation and agricultural production; and food quality preferences. Changes in agricultural technology have effects of food consumption both for the families of producers and for consumers. Secondly, changes in farm management and production technology have not always been beneficial for the food consumption status of producers. Thus it is important to understand the linkages between production and consumption in choosing development alternatives. Some of the more important linkages include: 1) seasonality of production; 2) crop mix and minor crops; 3) income; 4) the role of women in production; 5) crop labor requirements; and 6) market prices and their seasonality.

FSR/E provides an excellent methodological framework for understanding the local food systems that are targeted for sustainable agricultural development. Diagnostic surveys can help identify the critical food resources available in a specific environment that needs to be sustained and managed. Such surveys also help identify the adaptive strategies farmers pursue to protect household food security. Data can be collected during the design phase to assess a proposed intervention's potential impact on food consumption. In the selection of interventions for design and testing, technologies and practices can be promoted that have a positive impact on consumption patterns. For example, seasonal food shortages might be addressed by introducing early maturing food crop varieties; intercropping or relay cropping strategies, or improved water management. To avoid increasing labor demands on women's time, attention could focus on labor saving technologies; supplementary non-staples and cash crops that do not compete with food crops. Post harvest interventions may also help improve food security through improvements in storage, processing and preservation techniques. Similarly, marketing interventions could improve household consumption patterns.

A thorough understanding of the food system through FSR/E will allow for the selection of sustainable technologies and practices that will enhance the food security of farm families. These interventions are not just crop or livestock specific, but may be oriented toward post production practices, marketing, and/or national policy.

162> ZONING SURVEY: AN INTEGRAL PART OF DIAGNOSIS AND DESIGN

Tom Gillard-Byers, M.J. Blackie

Key Concepts:

Zoning survey: A Rapid Reconnaissance Survey designed to increase the efficiency of all Diagnostic Surveys. T1L is the loss in efficiency due to institutional barriers. T2L is the loss in efficiency due to poor understanding of socio/cultural and physiographic environmental factors. T3L is the loss in efficiency due to equipment or technical failures.

It is necessary to ensure that field level accomplishments are not lost due to institutional barriers, poor understanding of the factors of production and/or disruptions resulting from mechanical failures. Farming systems diagnostic surveys are susceptible to losses in efficiency of these types.

For the purposes of this paper the authors consider three type of losses in efficiency. Losses associated with institutional barriers are identified as Type 1 loss (T1L) in efficiency. T1L will invariably be accompanied by Type 2 loss (T2L) which results when interruptions in the field level activities occur as a result of earlier disruptions at the institutional level. Type 3 loss (T3L) in efficiency would result from equipment failures in the field. T2L in efficiency may occur independently of either T1L or T3L. T1L and T3L loss in efficiency will always result in T2L in efficiency.

In Malawi, Southern Africa the Adaptive Research Programme (ARP) methodology calls for diagnostic surveys to be carried out prior to the implementation of research activities. Research activities are to be based upon the results of these surveys. The diagnostic phase of the ARP provides opportunities to incorporate Commodity oriented research scientists and Extension staff. It is critical to avoid T1L in efficiency during the development of linkages between research and extension.

The Zoning Survey concept was developed and implemented in Malawi to avoid T1L and T2L losses in efficiency during the course of diagnostic activities. Subsequently, the concept was incorporated into the Malawi Adaptive Research Programme diagnostic survey process.

The Zoning Survey evolved to address existing institutional barriers which restrict entry into the field and a lack of knowledge on behalf of ART members pertaining to the socio/cultural and physiographic characteristics in a given area. Malawi Extension

Service is well structured and capable of facilitating efforts of this type when fully participating. Likewise, when proper procedure is not followed institutional barriers may be encountered.

Thus, the potential to sustain T1L in efficiency exists at any of several administrative levels. In Malawi and in many other countries it is likely that an integrated Adaptive Research Programme will perform better when these barriers are removed. The appropriate time to remove the barriers is prior to the diagnostic survey and after preplanning has occurred. This entails the use of a Zoning Survey to avoid T2L in efficiency.

In addition, the paper investigates administrative and technical barriers to implementation which may exist. The structure of the Malawi Department of Agricultural Research (DAR: the organization within which the Extension Service and the ARTs operate) is formalized. As such, a diagnostic team entering an area will first need to deal with issues both through the DAR and the DOA at several administrative levels.

Technical barriers to implementation may result from poor knowledge about a variety of diverse disciplinary concerns. Ethnic groupings, geographic inaccessibility due to rainfall (the Informal Survey is designed to be undertaken when crops are in the field), poor understanding of general soil characteristics, cropping systems and micro ecological zones in a given area all promote increases in T2L loss of efficiency. Technical gaps may continue to exist even after an intensive secondary literature review. The ZS is discussed as a technique for removing technical barriers.

The paper deals with opportunities for diffusing organizational conflicts associated with larger groups through the use of the Zoning Survey. An ideal Zoning Survey Team may include an individual with knowledge of soils and cropping patterns, an Adaptive Research Team socioeconomist and agronomist, and individual with knowledge of livestock and mixed cropping systems and a technical assistant (TA). The TA will be expected to provide a link between the field assistants, the DAR and the DOA personnel. Informal Surveys (IFS) will frequently be undertaken by individuals who have little functional experience. Under these circumstances it is unlikely that the concept of "Recommendation Domain" (RD) will be well understood. If this is the case the ZS will act as a mechanism to avoid T2L in efficiency associated with poor knowledge of the IFS process.

A discussion of necessary technical requirements for the ZS are also included in the paper. This provides a basic set of parameters to ensure more efficiency in undertaking the IFS.

Incorporation of ZS results into the IFS process completes the active phase of the ZS. The results of the Zoning Survey should include a basic set of outcomes. These are elaborated upon in completing the discussion of the usefulness of the ZS. The outcomes reduce T1L, T2L, and normally, T3L in efficiency. Increased efficiency, which invariably results, saves scarce monetary resources for research and extension. At the same time the ZS promotes the development of more useful interventions which impact positively on the producer in both the short and long run.

THE FIRST STAGE: PARTICIPATORY INFORMATION HANDLING <163

Ruth Grosvenor-Alsop

Information about the micro-level social, technical and economic context of any technological intervention is essential before, during and after main project activities. Information of this nature can ensure the appropriateness of interventions in both the long and short term. Intervention by definition brings change to a system. Project personnel and participating parties need to know what components of a system will be affected by this change if they are to minimize detrimental effects and maximize beneficial effects. These effects can be direct and indirect; they can change over time, and they can have a differential impact on various groups within a community or society.

Information gathering often proves to be an intrusive activity which can alienate the very people that the project wishes to assist. One way of overcoming this problem is to include informants in the information collection process. Their inclusion hinges on their understanding of project objectives and the need for particular kinds of information. Participation of project beneficiaries in data handling accesses local knowledge not usually available to those using a standard questionnaire approach. This knowledge guarantees that the quality and breadth of information are greater. This assists assessments of how technology fits into a system and indicates what intrastructural and intermatrial support its introduction may demand immediately and in the future. In addition to this participation means that farmers are able to identify with the project if a project is seen to develop according to mutually gathered and verified information local interest is raised. Participation in information gathering can help take project beneficiaries/farmers to the critical point where awareness forms the basis of interested activity. This point is crucial to the animation process which ensures the continuation of project activity once external personnel have withdrawn - that is, it supports sustainable project activity.

Through examination of project experience in Kenya this paper will discuss the process and means of including farmers in data handling as incorporated into a participatory project approach. The Intermediate Technology Development Group (ITDG) has been developing methodologies for farmer participation in its agricultural projects in order to ensure the future sustainability of these projects. One such project, focusing on the provision of de-centralized animal healthcare as part of the changing farming system was initiated in Machakos District in Kenya in 1988. Based on experience in India and elsewhere in Kenya the projects initial aims were to train community elected animal first aid workers (CAFAWs) and to establish an institutional framework which would ensure sustained activity by these, and new CAFAWs once the three year period of intensive project activity was over.

In this case ITDG is working collaboratively through a local Community Development Group. Rather than draw up a proposal of activities structured in the standard project-cycle format, ITDG and their collaborators drew up a phased and flexible set of objectives and schedules. The flexibility was considered essential if the project was to be seen to be responsive to local conditions and opinions.

Another of ITDG's strategic aims is to strengthen local institutional capabilities. Both formal and informal institutions are considered. The information gathering exercise (to check assumptions, set priorities, and begin to understand exante the impact of various strategies) which formed the initial project activity was agreed on by all parties involved in the Machakos project.

This paper will specifically focus on the ways in which the collaborators staff, the community, the informants and other interested parties ie. traditional healers and government veterinary staff, have been drawn into the data handling exercise - and hence the project. In doing this it will also examine various techniques of participative information handling through the four stages of gathering, recording, presenting and analyzing and the ways that these have been adapted to suit different user groups. Reference will be made at this point to a larger project concerned with rainfed farming technologies in the Chotanagpur Plateau of N.E. India in which a participative methodology has been adapted for a larger scale of operations.

AN EXAMINATION OF THE FREQUENCY OF STATISTICALLY SIGNIFICANT FARMER-TREATMENT INTERACTION IN RWANDAN ON-FARM TRIALS <164

Boyd J. Hanson, Val J. Eylands

The extensive use of on-farm trials in agricultural research is a recent phenomenon. The methodologies used in these trials have often been copied directly or with minor adaptations from methods developed for on-station trials in Europe and North America. These techniques may also be appropriate for on-farm trials; but some

researchers question whether certain, basic assumptions of the methods can be met, especially in the context of developing countries where they are often used.

The placement of on-farm trials in a randomized complete block design, with farmers as blocks and only one repetition per farm, is an example of a technique whose appropriateness has been questioned. The alternative proposal is that there must be replication on each farm. Without regarding the statistical implications of the design, there are advantages and disadvantages of each design, in terms of logistics, extension potential, etc.

Researchers who object to the use of the unreplicated design on statistical grounds believe that the assumptions of the design are often violated in on-farm trials. One of the basic assumptions of the randomized complete block design is that the blocks are homogeneous within themselves. Given the soil heterogeneity of many farmers fields, finding homogeneous block may not be practical. A second assumption is that the treatments will have the same relative performances in all blocks. The violation of this assumption inflates the error term used to test treatment differences and results in an incorrect test. Since many treatments tested in on-farm trials have different responses to the environmental variability which exists in different farmers' fields, it has been proposed that this assumption is often violated.

We examined on-farm trials conducted in Rwanda for violations of the latter assumption. We used data from on-farm trials conducted by researchers on the National Agricultural Research Institute of Rwanda (ISAR) or by researchers in agricultural development projects in Rwanda. For trials where there was only a single repetition, we tested the assumption using Tukey's one degree of freedom test for additivity. For trials where there was more than one repetition per farm, we calculated the farmer-treatment interaction, then sampled one repetition and reran the analysis using Tukey's test. These two results were compared. Trials were classified in terms of numbers of farmers, numbers of treatments, trial type (varietal, agronomic, etc.) and crop examined. The incidence of significant farmer-treatment interaction was then examined in terms of this classification.

We found the frequency of significant ($p < 0.05$) farmer-treatment interaction is generally in the range of 10-20%. This frequency is only slightly higher than the 5% level which would be expected due to chance alone.

165> FARMING SYSTEMS RESEARCH/DEVELOPMENT IN SIDUNZI TOWNSHIPS ON THE SEMI-ARID AREA OF NING XIA HUI AUTONOMOUS REGION

Long Rui Jun

A Farming Systems Research/Development (FSR&D) was conducted in Sidunzi Township of Yang Chi County on the semi-arid area of Ning Xia Hui Autonomous Region, China. The traditional ways of production and management were studied and inquired by using FSR&D as an approach.

Sidunzi township is located on the southern edge of Maowusu Desert in North West China, (E37 45'–46', N107 23'–25') with hard natural conditions and a fragile ecosystem. Its lack of water and soil fertility are the principle limiting factors of exploiting productivity.

Before 1986, the agricultural production in Sidunzi was still poor. The most (96.5%) of the total energy of primary production was consumed to maintain the agro-system itself. From 1986 to 1988, FSR&D approach was applied to the research and extension instead of the old methods. A research for adjusting structures of cropping land, forest land and forage land has been taking place over three years and changed their rate as 4:8:20. The proper ratio of summer grain, autumn grain and economic crops is favorable to the systems stable development and to increase its economic benefits. The proper ratio of summer grain, autumn grain and economic crops should be changed from 6:3:1 to 5:3:2. The farmland production has been influenced mainly by summer grain. Home economy has grown out of nothing, increased rapidly. Output value of home economy accounts for 9.3% of the gross output value of agriculture in 1988. For developing the animal husbandry, the usage of resource must be improved, and it is necessary to develop better market. The proportion of female Tan-Yan has been increased from 47% in 1986 to 64% in 1988 by adjusting the structure of Tan-Yan flock. The rate of marketable sheep was increased from 25% in 1986 to 38% in 1988. This raised the rate of commodity of animal productions. The output value of animal husbandry accounts for 19.9% of the total output value of agriculture in 1986. It increased to 22.2% in 1988. The forestland and grassland area has increased since 1986. The grassland was enlarged 1659a. And the forestland was increased by 1415a. The coefficient of water and soil conservation of farmland, forestland, grassland is 0.54:4:2.94. The ratio of the sunlight potential of dry-farmland, grassland and forestland is 1:3.57:1.03. The ratio of water potential of crop and grass is 1:1.62. However, increasing the covering rate of grassland and forestry has advantages both in using natural resources and in improving the ecological environments. The desert erosion would be decreased. The underground water resources were exploited and used rationally. There are 296a the irrigated farmland in Sidunzi.

The changes to farming systems influenced strongly farmers. They have received big benefits from the new farming systems, they are therefore receptive to new science and new technologies. Especially women have a positive role in the new farming systems and more field works are carried out by women such as, feeding and managing and so on.

The farming systems research has got initial results in the township. The total value of production of all township grew from 1.15 million yuan (RMB) in 1986 to 1.45 million yuan (RMB) in 1988. The average income is now 753 yuan per farmer. The total grain yield was raised from 750t in 1986 to 900t in 1988. The average grain yield is 817kg per farmer. The energy output/input ratio was 2.03. It is close to the highest value of 2.34 in Shanghai suburbs, China.

The developing process and trends in Sidunzi show that we should not be pessimistic for developing agriculture of the semi-arid area in Ning Xia.

In my paper, I discuss about the population increase and how it affects the farming systems also.

166> GENDER ISSUES IN FARMING: A CASE FOR DEVELOPING FARM TOOLS SPECIALLY FOR WOMEN

Ravindra Kaul

Women in Africa are estimated to contribute up to 70% of labor in food production and nearly 100% for rural food processing. Their range of daily activities like food preparation, water and fuel carrying, farm weeding, crop threshing, and preparing dairy products etc. are far wider than men and demand high human energy.

Despite awareness of above, most technologies developed for small scale farmers are geared for men with no concern for their 'appropriateness' for women who possess different anthropometric geometry and energy levels in comparison to men. The availability of separate bicycles for ladies as distinct from men's bicycle illustrates a commonly understood case of providing equipment based on gender issue.

This paper examines the range of farm tools and processes that are predominantly used by women and explains, with available research data, the inadequacies of such tools and processes when linked to women anthropometric measurements and energy levels. Specific tool design examples for operations like pounding, weeding and rural milk processing are highlighted to show the applications of research studies. It also illustrates the need and scope to design and develop farm tools specifically for use of women operators for overall ease of drudgery, safety and effective integration of women in farming systems innovations.

FOOD FARMING IN A DECLINING COCOA ECONOMY: HOUSEHOLD ORGANIZATION AND FOOD SALE IN DIVO REGION, COTE D'IVOIRE <167

Barbara Lewis

This paper explores peasant cocoa farmers' gains from and constraints on food production in a context where government and consumer interests in increased domestic food production are clear. Given stagnating producer prices for cocoa, peasants' income generation through food sales would appear increasingly attractive. This paper seeks to explain variations in incomes from food crops and cocoa by differences in the household (and gender) organization of agricultural labor among the culturally heterogeneous population studied.

Re-interviewing households studied by economic anthropologist Robert Hecht in 1978-79 in Divo region, Cote d'Ivoire provides the longitudinal dimension crucial to understanding agricultural change. This micro study, based on interviews of men and women and from 45 households in one village, first in 1978-79 and then in 1988-89 thus complements macro economic analyses of West Africa's economic crisis.

The current decline of cocoa prices on the international market and Ivoirian government's desire to save foreign exchange through food self sufficiency have resulted in national policy declarations and initiatives to increase food production for in-country sale. The paper assesses the impact of government policies, (price and marketing policies, input subsidies and supplies, and extension programs) on peasant farmers. Competing explanations of poor policy performance (explanations deriving from conflicting state interests vs budgetary constraints due the state's fiscal crisis) are assessed.

The impact of farmers' wealth (access to land, capital, labor) and ethnic identity (cultural differences in cropping systems and household use of male and female labor) on food sales are also assessed. For all farming groups, the well-established preference for cocoa as a cash crop shapes resource availability for food cropping. Since small land holders from all three ethnic groups in this village economy (Dida autochtones and Baoule and Dioula alloctones) have commonly planted ALL their land to cocoa and coffee, their access to land for food cropping (subsistence or commercial) depends on a land rental market troubled by personalistic and political considerations. The emergent system of land rental and sharecropping for food crops not only constitutes a new production cost for the land poor limiting profitability. It also precludes certain cropping "packages" and discourages long term investment in land productivity by land renters.

The gender division of labor varies by ethnic group. The patrilineal Dida autochtones rely largely on female family members or paid labor for food production, while allochtones (Dioula and Baoule) more fully mobilize household labor for food cropping. Despite very different social systems, (patrilineal, grain producing Dioula contrasted with matrilineal, tuber-producing Baoule), both allochtonous ethnic groups permit women to sell, on their own account, some of the foods they produce. While some women do innovate to increase their profits, their limited ability to mobilize labor and other resources limits the profitability of their efforts. Men's income from food cropping is also limited by (female) competition and risky, high cost marketing channels. With exception of rice, an easily stored grain, and some dried condiments, food cropping in central Cote d'Ivoire, is characterized by risk of market failure due to periodic oversupply, perishability, and high cost, unreliable transport. These characteristics detract from food farming as the main source of household income, and explain, perhaps more than profitability levels, peasants' commitment to cocoa farming.

FARMING SYSTEMS RESEARCH AND EXTENSION RELATIONSHIPS: METHODOLOGICAL ISSUES AFFECTING IMPLEMENTATION AND EXTENSION OF RESEARCH RESULTS <168

Patrick J. Ludgate, Tjeppy D. Soedjana

This paper discusses several principal issues effecting the integration of agricultural researchers, farmers and extension service personnel in relation to on-farm production technology development and testing. Constraints on the structure, organization and promotion of agricultural research and extension can have a definite impact on the ability of agricultural researchers to conduct on-farm research. A recognition of the important role the extension service can have in the communication linkage process between farmers and researchers is required by researchers.

A risk-income indifference model is used to illustrate small farmers constraints toward technological change. This indifference model is then extended to describe farmer-extension-researcher interaction throughout the on-farm research process. The model uses a dual axis graph in order to incorporate the individual farmer's risk indifference curves with Potential Pareto criterion for technology acceptance.

FOOD PRODUCTION IN THE SESHEKE DISTRICT OF NORTHWESTERN ZAMBIA <169

Elias Mandala

Four decades of intensive cattle-raising and labor migration since the imposition of colonial rule in the late 1890s, left the food economy in the Sesheke District in the same predicament as did cotton production in Southern Malawi or land confiscation in Southern Rhodesia. It was a distorted economy characterized by chronic food shortages and occasional famines. The diversion of male labor from food production had initiated a new pattern of human interactions with nature through the labor process. Single women and the elderly, who made up the stable population of new village communities, had abandoned labor intensive floodland agriculture (*sishango*). They had concentrated agricultural work on the fragile and infertile drylands, which exposed the food economy to the dangers of drought. The end of the *sishango* system had increased the vulnerability of the rural population and made them more dependent on the market economy (including wage labor) for survival. The producer of use-values in Northwestern Zambia had become as much 'captured' as the producer of cotton in Southern Malawi. by withdrawing labor from the food economy, capitalism and colonialism effectively eliminated the 'tribal cultivator' as a meaningful social category.

Rural responses to the growing food crisis — probably the most salient indicator of the process of peasant formation in Africa — varied greatly. Like the male youth from poor households, single women who had no access to cattle or extra-household labor, migrated to the cities, often in defiance of the orders of the colonial state and village elders. The policy that opened the mining compounds to married women represented, to a large degree, the triumph of the struggles of rural women to escape their impoverishment.

As the village poor flocked to the Copperbelt, the well-to-do intensified cattle-raising, especially after the ban on the export of cattle from the region was lifted in the late 1920s. A thriving cattle trade during the 1930s promised to revive and restructure the food economy. Wealthy cattle-owners invested part of their income in ploughs. The number of ploughs imported into the region rose dramatically from the mid-1930s, when the arrival of many lumber-cutting companies created a demand for locally-produced foodstuffs.

The introduction of the plough did not, however, raise agricultural productivity in Northwestern Zambia. The plough was a form of piecemeal technology that still required human labor. In the

absence of a significant shift in the established village-to-town migratory trends, the plough proved to be more of a curse than a blessing. Large fields were opened but there were no laborers to do the sowing or weeding. Denuded of their original vegetation, the large fields became the first site to be identified with the problem of soil erosion. An uncontrolled cattle grazing exacerbated the problem of land degradation in the District.

The response of the colonial state to the disruptions in the reproductive cycle of the peasantry in Northwestern Zambia was quite unique. Unlike their counterparts in colonial Malawi, Tanzania or Zimbabwe, the British in Northwestern Zambia did not try to introduce new techniques of production. Instead, they launched upon a propaganda for the revival of the old *sishango* system. The propaganda failed for two main reasons. First, the rise in the water level of the Zambezi River from the early 1940s curtailed the expansion of the *sishango* regime. The second reason was more structural. *Sishango* presupposed a division of labor in which men participated in agricultural work alongside their women. It required reversing the trend toward male labor migration and the deployment of male youth labor within the expanded cattle economy.

170> COMMUNITY-BASED INFORMATION SYSTEMS FOR FOOD SECURITY MONITORING: THE ROLE OF THE SUDANESE RED CRESCENT IN NORTHERN DARFUR, SUDAN

Richard Margoluis, Mohammed Omer Mukhier

Summary: In the recent past, much of the African Sahel has been subjected to decreased rainfall and declining food grain production. Because of these factors, residents of this semi-desert zone have been plagued by severe food shortages and famine that have caused extensive destitution and death. In the Sahelian zone of western Sudan, an innovative operations-research project has demonstrated that indigenous organizations can provide the necessary infrastructure and support to ensure adequate food security by promoting community-based self-help practices. For the past four years, the Sudanese Red Crescent (SRC) Drought Monitoring Program (DMP) has been the key actor in the detection of deteriorating food security, and in the targeting and delivery of relief in Northern Darfur, Sudan. Only by mitigating the risk of famine will more long term agricultural development projects be given the chance to succeed.

In order to promote viable and sustainable agricultural practices in the African Sahel, farmers must be relatively confident that they will consistently secure enough food to feed themselves from one year to the next. In years of good or normal rainfall, most farmers produce enough sorghum or millet to cover their family's food needs, as well as to set aside small amounts of reserve stocks for times of dearth. In years of poor rainfall, farmers must rely more heavily on reserve grain stocks, livestock resources, alternative sources of income and emergency relief assistance to feed themselves. If drought persists for more than one agricultural season, farmers become exceptionally vulnerable to severe food shortages and famine. As more and more people become destitute, grain prices skyrocket, livestock prices plummet, seasonal jobs become scarcer, and more families abandon their communities in search of food. Often, as in the drought of 1984 through 1985, thousands of people face death by starvation as social and cultural order disintegrates.

Sudan, which is the largest country in Africa, stretches from the Nubian-Libyan Desert in the North to savannah and deciduous forest in the south. The Sahelian zone, between 12 degrees North and 15 degrees North, is the most vulnerable to periodic harvest failures because of high variability of rainfall. The province of Northern Darfur is considered to be the most vulnerable to famine as food production is highly variable, and it is not integrated into the national marketing system. The famine of 1984-85 which was particularly devastating in Northern Darfur, sparked a massive emergency relief operation which was supported by the Government of Sudan and bilateral and non-government organizations.

Among the agencies that responded with famine relief was the Sudanese Red Crescent (SRC), an indigenous private voluntary organization (PVO) based in the capital, Khartoum. The SRC was established in 1956, soon after Sudan's independence from Great Britain. The SRC involves itself with three main functions: minimization of the effects of disasters, rehabilitation after disasters, and community development. One of the major goals of the SRC is to support village-level initiatives, through traditional self-help systems, in order to promote community development. The SRC is composed of many community branch offices, and it is this decentralized structure which makes the foundation of the organization so strong.

The Darfur Regional Office of the SRC was established in 1982. By 1984, 19 branches were organized throughout Northern Darfur. Towards the end of 1984, the League of Red Cross Societies (LRCs) became heavily involved in famine relief operations. During this time some development activities such as the digging of wells and community farms continued while the number of branches grew to 67. At present, the SRC Darfur Regional Office concentrates on community-based self-help agricultural and development projects. However, one component of this office concerns itself exclusively with the monitoring of food security in the province.

The SRC Drought Monitoring Program (DMP) was developed after the famine of 1984-1985 when, with the help of the Relief and Development Institute (RDI), it began a pilot study to establish an information system for food security monitoring in Northern Darfur. It was believed that most of the destitution and death that was caused by the famine could have been prevented if accurate, thorough and timely information had been available concerning deteriorating agro-climatic conditions. For this reason, the SRC felt that it could best serve farmers in Northern Darfur by establishing an information and response network in the zone. Preliminary fieldwork was conducted to determine which indicators should be followed over time to get an in-depth understanding of changes in famine vulnerability. Early in 1985, a questionnaire was developed which was to be completed by SRC community branches and returned to the regional headquarters in El Fasher, Northern Darfur each month. Included on the data collection form are questions concerning crop conditions, rainfall, food and livestock prices, population movements and sources of extra income. By collecting and compiling the data forms on a monthly basis, it can be determined whether or not a community is becoming more or less vulnerable to famine.

The SRC DMP has already played a very important role in the mitigation of the effects of drought in Northern Darfur. In 1987, a failed millet harvest led to severe food shortages in the province. The DMP in collaboration with the Agricultural Planning Unit (APU) supplemented its normal monthly data collection with a pre-harvest assessment which identified the most affected populations. Based on this information, a large-scale relief operation was conducted by the Government of Sudan and Western Donors including the United States, Holland and the European Community. The DMP continued to provide field data that were used to monitor the progress of the relief activities.

As the DMP continues to develop and expand, more communities will be incorporated into the network. Thus, a wider geographical area of highly famine-vulnerable Norther Darfur will become more food secure. Only once farmers feel that their immediate food needs will be met and that they will not become destitute because of one failed harvest will they be able to look towards a more secure future.

OPTIMUM USE OF LAND WHERE IT IS SCARCE - FROM A FARMING SYSTEMS PERSPECTIVE <171

M. Moussie

One of the major characteristics of small farmers is lack of adequate resource endowments. In countries such as Burundi, small holdings of land is crucial for understanding and defining farming systems in which the farmer tries to satisfy his/her needs and priorities. Typical of a small farmer, a Burundi farmer has multiple objectives: provision of stable food supply, minimum risk, maintaining soil fertility and productivity, generating of minimum cash requirements, multiple crops, and overall security. In short, the small farmer wants to maximize the farming system in which he finds himself by sustaining the productivity of the farm, hence attain his multiple objectives.

A small but densely populated country, Burundi is facing a major problem in maintaining the fertility of its soils. Because of population pressure, cultivable land is getting increasingly scarce. This rapid degradation of soil and scarcity of land is threatening the very existence of Burundi small farmers. Managing of this scarce resource is a daily challenge for burundi farmers who account for 95% of the population and who cultivate three times (seasons) a year. This paper attempts to describe the land tenure system in Burundi, and how farmers allocate land among different competing enterprises according to their multiple objectives. From this background information, an optimum model of land use is proposed using the following determinants: household and farm size, cropping seasons, labor requirements, multiple objectives, competing enterprises/crops, crop association, and cultural practices.

THE USEFULNESS OF INDIGENOUS SOIL CLASSIFICATION IN RESEARCH AND EXTENSION <172

B. Mwale, M. Silavwe

This paper seeks to highlight the importance and usefulness of farmers a way of classifying soils based on indigenous knowledge. The farmer in his view has not developed a system of classification. The researchers however can collect information from farmers and come up with a system of classification.

Agricultural extension agents involved in FSR/E are often not in a position to explain to farmers and get from farmers information on soils such as preferred soils for certain crops, soil fertility, and crop performance using international soil classification systems because of their limited knowledge in this area.

The farmer is able to identify/distinguish one soil from another by describing the different soil characteristics and performance. It is important to consider indigenous soil classification in agricultural development since knowledge is drawn from the farmer and may be used effectively by both research and extension.

The discussion of the paper includes:

1. Farmers way of describing soils and the main soil group identified.
2. Indigenous soil classification based on consistency of describing one particular soil.
3. Indicators of fertility.
4. How helpful classification is to agricultural extension officers.

INCREASING THE ADOPTION RATES OF NEW TECHNOLOGIES WITH A NEW TECHNOLOGY TRANSFER MODEL <173

Ramiro Ortiz, Adlai Meneses

A new technology transfer model that was implemented since 1986 within the research-extension systems of Guatemala has produced a marked increase in the adoption rates of new improved materials among limited-resource farmers and generated impacting results that have already reached and surpassed the established goals for production and productivity of food crops. This model has its foundation in a set of strategies and methodologies that have affected mostly the extension institution -DIGESA-, which has been transformed by the knowledge and implementation of the Farming Systems Approach.

A methodological strengthening of the extension agency teams, based on initial training in Farming Systems Research and Extension Methodology, was necessary to guide DIGESA toward and throughout the new technology transfer model. This model includes, but is not limited to, the following features:

1. Developing a strong research-extension inter-phase to "close the gap" between these two groups.
2. The direct involvement of farmers in the planning and execution of activities in all the phases of the technology innovation process.
3. Participation of rural leaders generating a "multiplying effect" in technology transfer through their work with organized groups.
4. Emphasis in the transfer and promotion of new technologies to reach larger groups and increase the adoption rates rather than give technical assistance to a reduced privileged clientele.
5. Enter the field of facilitation of new technologies; a most important feature that has allowed DIGESA to develop a successful non-conventional system for improved seed production and distribution among groups of limited-resource farmers.

With the field work conducted by 72 extension agencies during three years in five regions of the country, which included 5,929 transfer plots and innumerable promotion activities, over 50,000 farmers have adopted new technologies for food crops production. This level of adoption has been increased by the development of the non-conventional system for seed production and distribution in areas where small family farms predominate, and where in 1988 the farmers conducted 719 small seed plots that produced seed for 21,045 farmers. Through the use of the new technologies, it is estimated that the 1989 production of food crops in those areas will be increased by 16,200 metric tons; which is enough food to cover the needs, for one year, of little over 26,000 typical rural families. This increase will result from the use of new technologies for higher production and with a very small increase in cost that will not require credit.

WOMEN PROFESSIONALS IN AGRICULTURE <174

Susan Poats, Hilary Feldstein, Janice Jiggins

Women are being trained in the social and agricultural sciences, home economics, and extension. How influential are they in farming systems research and extension? What are the constraints to women's participation as decision makers and implementors? to their educational preparation? to career mobility and manageable family-work situations? What strategies have been employed to improve the situation of women professionals in agriculture? What policy oriented research or other activities would be useful?

On the day after the 1988 symposium, a workshop was held to explore these issues. It drew twenty-eight participants and resulted in a lively discussion of existing practice and ideas for change. This year's panel results from the specific request for a follow up, in depth examination of key points. The issues to be addressed are: (1) representation of women professionals in agricultural sciences; U.S. and developing countries; (2) representation of women in training in the agricultural sciences and barriers to such training; (3) women's participation in decision making and access to promotion; and (4) strategies and examples for including women professionals' effective participation in agriculture.

Four panelists are being selected who will draw on their experience with international agricultural research centers, regional research institutions, and national agricultural programs. Represen-

tation will be from Southeast Asia, Africa, and Latin America and the U.S. Each will make a short presentation, leaving the major portion of the time for discussion.

175> IMPLICATIONS OF FOOD CONSUMPTION/NUTRITION PROBLEMS, CONDITIONS, AND CONSTRAINTS FOR FOOD CROP PRODUCTION TRIALS IN THE BICOL (PHILIPPINES) FSR/E PROJECT

Marilyn Prehm, Lisa Haedrich, Ed de la Torre

The purpose of the research was to devise and test methods for describing the linkages between agricultural production and food consumption/nutrition in diagnosis and preliminary trial design and to describe the contributions of a nutrition focus to problem identification and treatment selection compared with an agricultural focus.

A multidisciplinary team integrated the consumption/nutrition perspective into the Rapid Community Assessment for Planning (RCAP) by incorporating topic areas, observational items, and questions in the five stages in the community diagnosis. The stages included: Secondary Data, Site Reconnaissance, Key Informant Group Interview and Community Planning and were tested in one project site selected for variability in farming systems nutritional levels. Post field data analysis included tests for differences in nutritional levels by farming systems group, mean rankings of priority problem areas, and delineation of nutrition criteria relevant to treatment selection.

Three problems in subsistence food production and consumption were among the top five community ranked problems. Other problem areas included cash crop production problems, marketing, labor, and lack of inputs. In the agriculture RCAP nutrition related problems were reported only to a limited degree and their rankings were generally lower than in the consumption focused RCAP.

The principal nutrition problem in the community was protein energy malnutrition. Lack of food, as reported by the key informants was one of the major problems especially during times which appeared to coincide with high labor demands and increased sickness. In addition to seasonality; income, labor, enterprise mix, and markets appeared to be related to consumption problems. However, an analysis of available nutrition surveillance data indicated there were not statistically significant differences in nutritional status between different levels of diversity of enterprise mix (N=46).

Production factors identified for investigation related to the priority problem of food crop production included: crop protection, soil improvement, pest and disease control and overall plot design. Consumption/nutrition aspects related to research trials included: selection of crops and varieties for filling food, income and nutrient gaps; and other nutrition-related areas of sanitation, labor and post-harvest storage. Many of these aspects were based on data available in the nutrition focused RCAP and not included in the prior agricultural RCAP. Based on the nutrition/consumption related problems, conditions and constraints researchers formulated criteria for ex ante analysis. These included the categories of food and incomes gaps, food preferences, sanitation, household labor, and other resources.

Based on the high priority the community placed on consumption related problems and the relevance of these problems and related conditions and constraints for on-farm trials it is recommended that further consideration be given to nutrition/consumption during trial analysis and final determination of recommendation domains in this as well as in other FSR project activities.

176> THE IMPACT OF HOUSEHOLD SURVIVAL STRATEGIES ON FUTURE VULNERABILITY TO FAMINE: DARFUR, SUDAN 1980-88

Alison Pyle, Omer Abdel Gabbar

This study examines household vulnerability to famine in Northern Darfur and why some households were able to continue their productive activities in their villages while others were forced to migrate in search of alternative sources of income. Our framework of analysis is households' access to resources, both tangible and intangible, and their use from the period of the last good harvest before the famine through the most recent harvest. by choosing this time frame, we are looking at the use of resources during the famine and recovery periods and the present status of household economies.

The term "vulnerability to famine" is defined as the threat of a sudden, severe and prolonged food deficit, which occurs at the end of a process of declining economic conditions in which households are forced to sell their assets - including those necessary for production - in order to obtain cash to purchase food. Contributing to this vulnerability are social and political factors which may determine access to land and labor, affect choices on migration and impact on peoples' access to government and external aid.

In this study, we are looking at specific variables which may have either enhanced or limited peoples' ability to adapt to changing ecological and economic conditions in Northern Darfur. These variables include geographical location, ethnicity, socioeconomic structure and relations of production. The ethnic groups we are concentrating on are the Berti, who have traditionally been monocrop cultivators of millet, and the Zaghawa who were traditionally pastoralists but who have recently shifted to trade and cultivation. now resettled in Katal Rural Council, between El Fasher and Nyala, the Zaghawa in our study are originally from Dar Zaghawa which is mostly desert, far to the northwest of El Fasher. The Berti in our study, on the other hand, have remained in Mellit Rural Council, a semi-desert area with mainly goz soil north and northeast of El Fasher, and have diversified little in their form of production. In addition, the socioeconomic structure of traditional Berti society is more restrictive than that of the Zaghawa; since, for example, Berti sheikhs have the power to redistribute precious cultivable land if a household leaves a plot fallow for more than two years. This, in effect, limits both the distance of migration and the number of members a household can afford to send away.

The purpose of our study is to identify the push and pull factors of migration during both the famine and recovery periods, identify possible targeting criteria for relief and the timing and type of relief intervention required in order to strengthen the productive activities of people in their villages. We are trying to determine which factors lead to the migration of households to El Fasher during the famine, and what enabled other households to continue production in their villages.

Having interviewed 100 randomly selected households of Berti and Zaghawa migrants who arrived in El Fasher in 1984 and '85, we have identified their villages of origin and will conduct follow-up interview with individuals and households in one Zaghawa and one Berti village. In these interviews, we will be collecting oral histories of the experiences of households and individuals during the famine and recovery periods. We will also collect baseline data on the following issues: household asset holdings, investment and food stores before the famine and presently; household access to political and religious figures in the community before and during the famine; and the social status of the household before the famine and presently. This information will be gathered in the villages in formal interviews with household heads, using a questionnaire prepared in advance. We will also use participant observation to verify responses whenever possible. For information on individuals' access to and control over resources, we will interview other adult males and females in the household, using a separate questionnaire which focuses on the allocation of resources and responsibilities between gender and across generations. Participant observation

will also be used to verify response whenever possible.

From our preliminary survey in El Fasher, we have found that most of the migrants interviewed had arrived in one of two large influxes: the summer of '84 and the months of August through October '85, after a harvest failure. These two groups included both Berti and displaced Zaghawa, and their reasons for migrating were drought, crop failure, the sale of livestock at very low prices in order to purchase food, and livestock deaths. They came to El Fasher in search of food, services and employment in the informal sector, in which El Fasher is flourishing economic center. Many of the respondents reported having been familiar with El Fasher before migrating during the famine, as they had seasonally migrated for work and other income generating activities in prior years.

Income generating activities which existed in El Fasher before the famine today remain a strong factor in the recovery of household economies. Further integrating the rural and urban economies since the famine, households have found it more economically viable to spend the dry season in the informal sector in El Fasher and return to their villages to plant in early June. income earned in El Fasher is invested in rural production, when available, surplus grain is then brought to El Fasher to market, and the revenue usually goes into either trade. Unlike the pattern of seasonal migration before the famine in which only male household heads or other adult males would come to El Fasher for work, whole households are following the head of the household to El Fasher after the harvest. Many Berti respondents stated that income generating activities in El Fasher have been more profitable than working as agricultural wage laborers during the dry season. They are most commonly found in the leather industry in El Fasher, and the displaced Zaghawa dominate petty trade.

We are still in early stages of our research, but we plan to follow-up our preliminary survey with interview of households in the migrants' villages of origin. The final report will consist of data and analysis on the survival and recovery strategies of migrants in El Fasher and respondents in the migrants' villages of origin.

SWINE REPOPULATION IN HAITI - FACTORS FOR SUSTAINABLE ANIMAL AGRICULTURE <177

Gregory M. Sullivan, Raul Hinojosa

In the late 1970's, African Swine Fever (ASF) spread into Haiti decimating large numbers of pigs. A multinational donor effort, spearheaded by the U.S. Government, eliminated the indigenous creole pig to eradicate the disease. The donors initiated a major repopulation program using improved varieties of pigs. Few opportunities exist where animal agriculturalists can study the impacts of completely changing the genetics of a domesticated livestock for a country. This case presents first hand information on the constraints and opportunities for other developing countries.

This paper will report on the design, implementation and evaluation of the Swine Repopulation Program (SRP) in Haiti. Important lessons to be learned for animal agriculture in farming systems will be documented. A national farm survey was conducted to measure technical, social and economic impacts of the repopulation program on peasant farmers. Research findings will highlight the factors that are pivotal to the operation of the program and the long term sustainability of swine production in Haiti. Information on peasant attitudes toward input services and market infrastructure will indicate fundamental principles important for sustained animal systems.

The SRP in Haiti illustrates that improves animal genetics is a necessary component of a sustainable system, but the Haiti experience proves that genetic improvement is not the sufficient by itself. This paper will layout in a logical framework what the authors consider are the required components in a logical framework for sustainable animal agricultural programs. The findings are important for practitioners, extensionists and researchers interested in designing and implementing animal agricultural projects with an orientation to FSR/E.

COMPOSTING FLUSH TOILETS? A STUDY OF DECISION-MAKING IN A FARM COMMUNITY IN COLOMBIA <178

Ignacio Villa

The disposal, treatment, and/or recycling of human excrements has serious implications not only for public health but also for agricultural sustainability. In Colombia, the officially sanctioned technology for handling human wastes, both in urban and rural settings, has bee the use of flush toilets. However, while the focus has been on the toilet, much less attention has been paid to the safe disposal, treatment, or recycling of effluent. One NGO working with campesinos through several demonstration farms and direct technical assistance, has promoted a simple composing toilet as an alternative that address two main issues of importance to farming communities: the contamination of scarce water supplies, and the improvement of soil fertility. There are now reports that in several farming communities the composing toilet is being adopted independently of targeted extension efforts. This presents an interesting case in which the adoption of two fundamentally different technologies can be studied. The two technologies represent two very different approaches to the management of human excreta. Whereas one approach views excreta as waste, the other views it as a resource.

This paper attempts to shed light on the kinds of factors that influence the choice of technology by campesino households. What kinds of forces are at work in the decision making process? Do campesino households have a latent mechanism for evaluating the appropriateness of the technology, and how does it operate? How have the campesinos acquired knowledge about the various alternatives? To what extent are their decisions based on awareness of environmental quality issues specifically related to water and soil quality? These are some of the questions the author will attempt to find answers for in field studies carried out during June, July, and August of this year. The analysis is carried out using a conceptual framework borrowed from the literature that differentiates endogenous acquisition systems from exogenous delivery systems as mechanisms for technology adoption. The relationships between these systems and the choice of type of toilet will then be analyzed.

DEVELOPING PRODUCTIVE AND SUSTAINABLE FARMING SYSTEMS IN THE SMALLHOLDER SECTOR OF SRI LANKA <179

Ravi Sangakkara

The agricultural sector of Sri Lanka is characterized by a plantation sector with colonial past and a peasant smallholder sector. While the former consists of well managed plantations, the latter contains food producing units, namely lowland rice fields and upland irrigated and rainfed annual cropping systems. In addition, some smallholder units, especially in the wet zone of the island contain perennial crops such as tea, rubber, coconut and spices.

The smallholder agricultural sector has been considered a vital component of the agricultural development plans of Sri Lanka. This is due to their role in alleviating unemployment and urban population pressures, along with increasing productivity of the crops to meet local food requirements and the export demand of specialty crops such as the spices.

The smallholder units of Sri Lanka, especially those producing food crops in the drier regions are subsistence farming units. They achieve very low levels of production under rainfed conditions, especially in the dry season. The farmers of these units adopt traditional methods of production, and the sustainability of these units is extremely low due to poor management of resources.

Farming systems research and extension programs carried out in different parts of the tropics and to a lesser extent in Sri Lanka has identified means of improving productivity of the subsistence smallholder units. Studies carried out not only show increased yields but provide guidelines for the development of sustainable

systems. Thus, research on the adaptability of the proven systems have been carried out on selected farmer fields. In the perennial systems, plans are made to increase the productivity and profitability of the more marginal units.

The paper presents the role of farming systems research and extension in increasing the productivity and maintaining the sustainability of the smallholder systems of Sri Lanka. Examples of case studies carried out by the author on rice units, where interseasonal relay cropping is used and in rainfed upland systems where mixed, multiple and avenue cropping is used are presented. Other studies on the perennial sector such as smallholder tea, rubber, coconut and spice crop units are also presented, These examples highlight the usefulness of adopting the farming systems concept in developing productive smallholder units. In addition the role of extension is discussed especially in terms of surveys to determine farmer needs and the development of on farm trials. Emphasis is placed on the possibilities of achieving viable, productive and sustainable farming systems in the smallholder units, which play a principle role in the agricultural sector of Sri Lanka.

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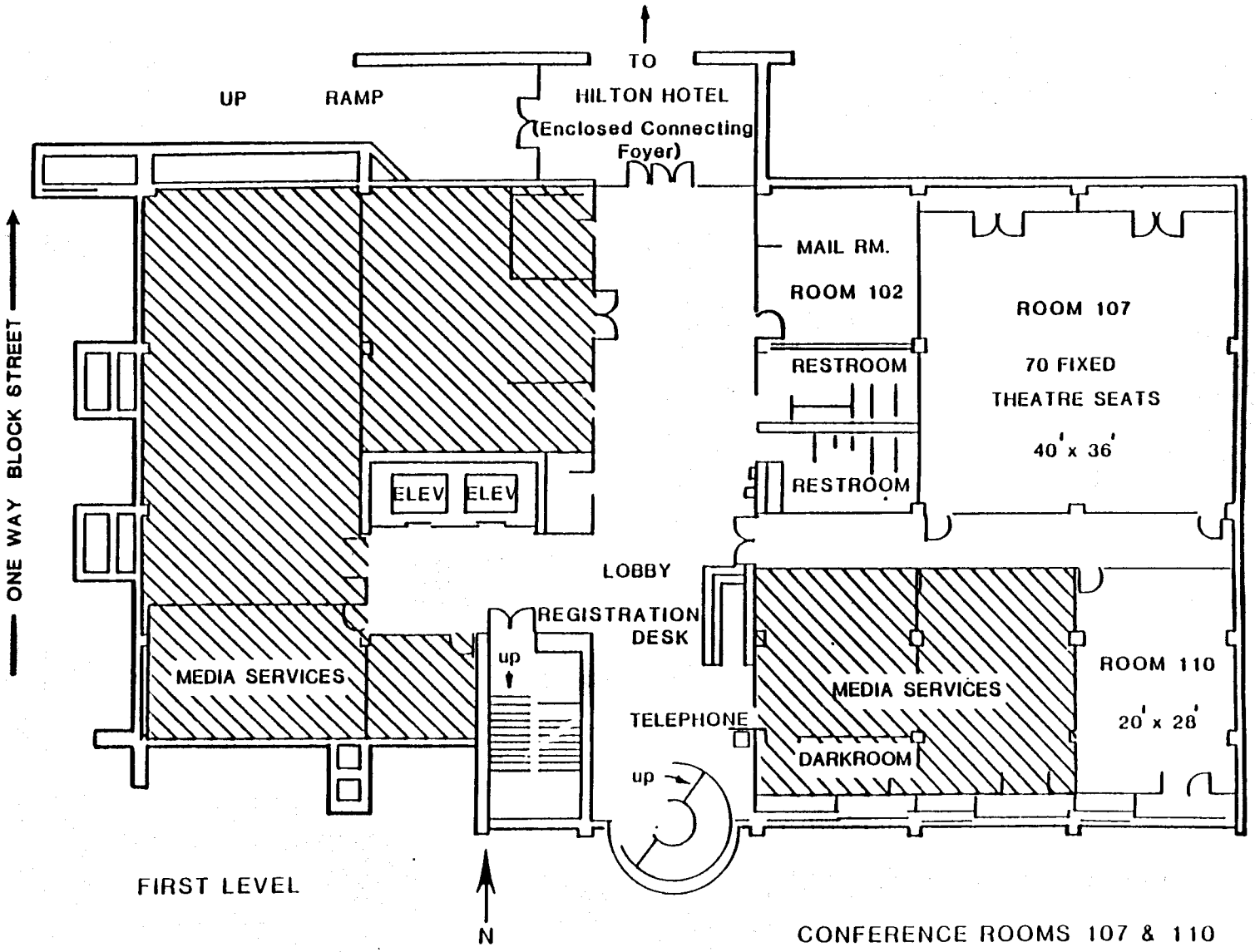

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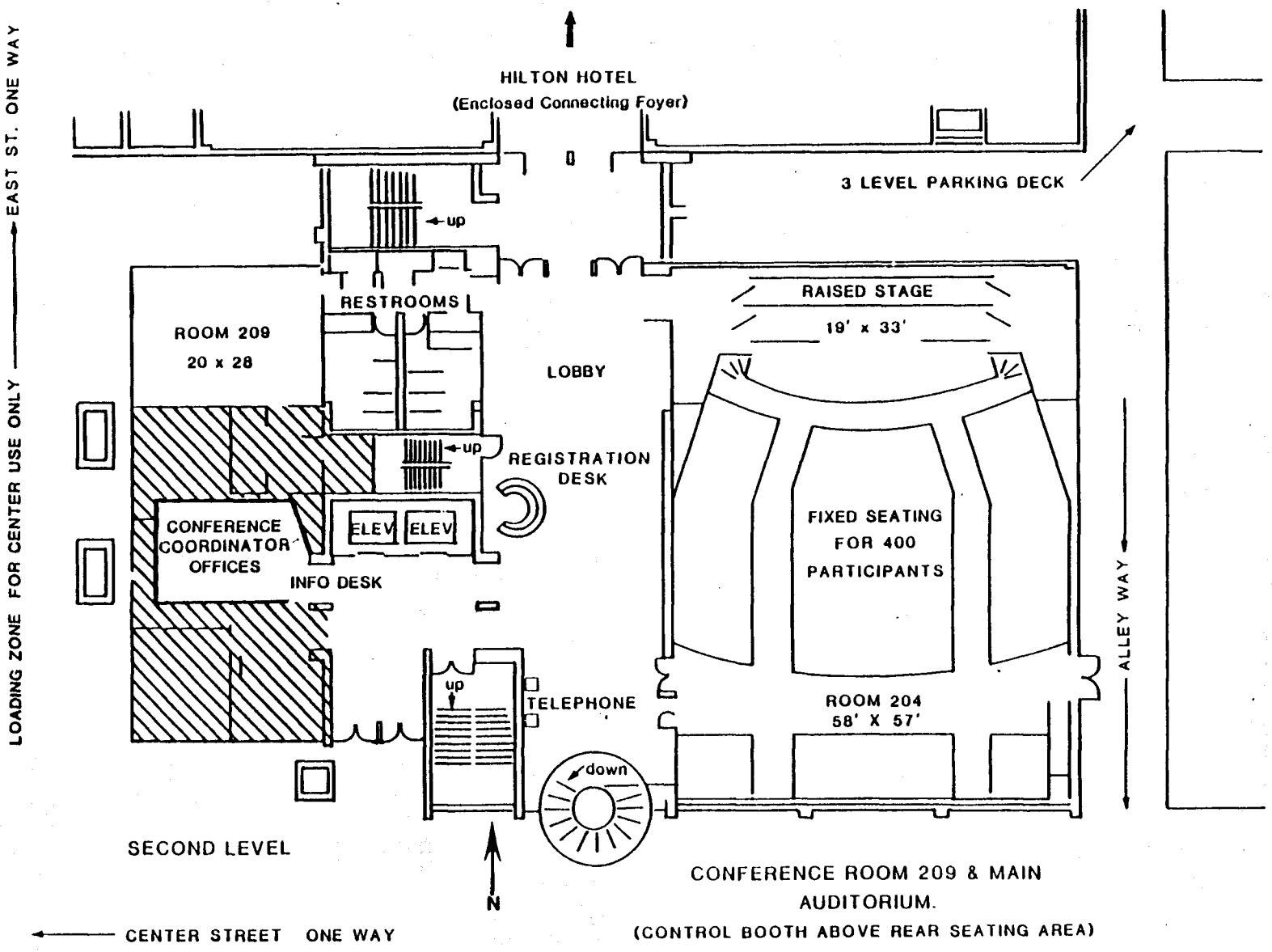
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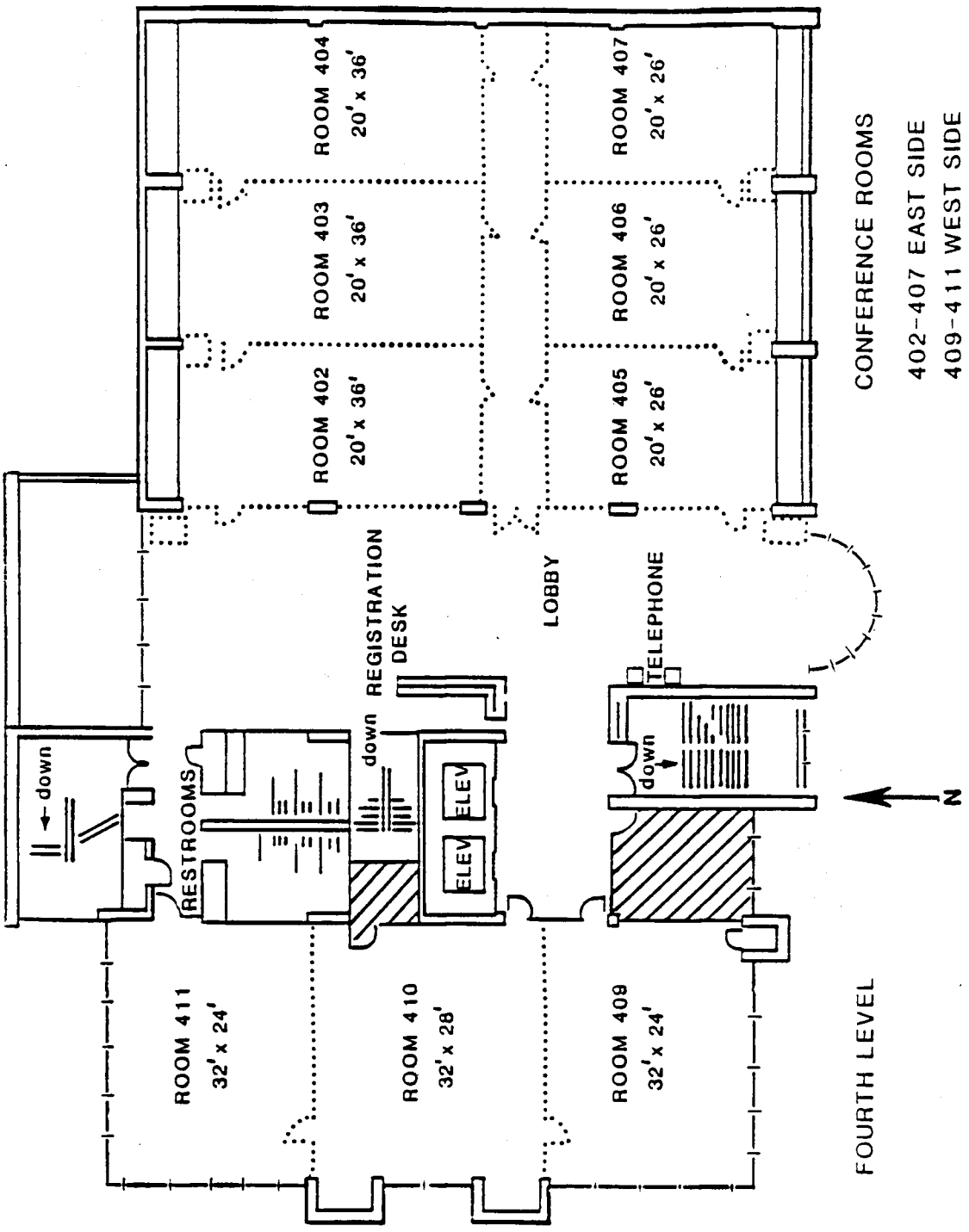
LOADING ZONE FOR CENTER USE ONLY
up
RESTROOMS
ROOM 209
20 x 28
LOBBY
RAISED STAGE
19' x 33'
up
REGISTRATION
DESK
CONFERENCE
COORDINATOR
OFFICES
ELEV
ELEV
INFO DESK
FIXED SEATING
FOR 400
PARTICIPANTS
ALLEY WAY
up
TELEPHONE
ROOM 204
58' X 57'
down
SECOND LEVEL
N
CONFERENCE ROOM 209 & MAIN
AUDITORIUM.
(CONTROL BOOTH ABOVE REAR SEATING AREA)
CENTER STREET ONE WAY



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CC