OFFICE OF INTERNATIONAL
AGRICULTURAL PROGRAMS
U.S. AID TITLE XII
STRENGTHENING GRANT

# PROCEEDINGS OF KANSAS STATE UNIVERSITY'S 1982 FARMING SYSTEMS RESEARCH SYMPOSIUM

## FARMING SYSTEMS IN THE FIELD

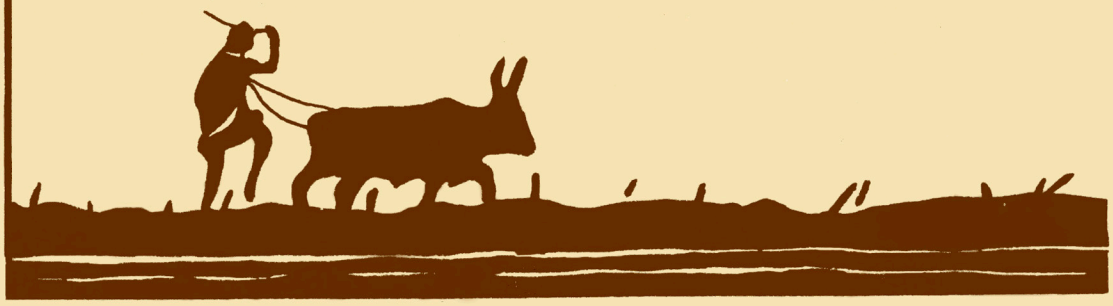
Edited by Cornelia Butler Flora

Compiled by
Wendy J. Sheppard

Paper No. 5 April, 1983

FARMING SYSTEMS RESEARCH

PAPER SERIES



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

PROCEEDINGS OF KANSAS STATE UNIVERSITY'S
1982 FARMING SYSTEMS RESEARCH SYMPOSIUM-

# FARMING SYSTEMS IN THE FIELD

Edited by Cornelia Butler Flora

Compiled by
Wendy J. Sheppard

Paper No. 5 April, 1983

## FARMING SYSTEMS RESEARCH PAPER SERIES

Kansas State University's Farming Systems Research (FSR) Paper Series is supported by the U.S. Agency for International Development Title XII Strengthening Grant. The goal of the Strengthening Grant is to increase the University's capacity for, and focus its commitment to, implementing Title XII agricultural and nutritional development assistance programs in less-developed countries. This series is maintained by the FSR Program Associates-a multidisciplinary team of professors who are focusing their activities around applied research on farming from a systems perspective.

Those faculty involved in the FSR Group (past and present) include Ulysses Acasio (Grain Science and Industry), Charles Bussing and Duane Nellis (Geography), James Converse, Cornelia Butler Flora, Barry Michie, and Martin Ottenheimer (Sociology, Anthropology, and Social Work), J. Arthur Hobbs and L. Van Withee (Agronomy), Berl Koch and John Wheat (Animal Sciences and Industry), George Larson (Agricultural Engineering), David Norman (Economics and Agricultural Economics), Meredith Smith (Foods and Nutrition), and Dwight Wiebe (Adult and Occupational Education).

The purpose of the FSR Paper Series is to provide an avenue for disseminating information on FSR to those interested. Publications to be included fall into the following categories: updated bibliographies from KSU's FSR data base; proceedings from KSU's annual Farming Systems Symposium; selected papers presented in KSU's FSR Seminar Series; selected papers prepared by KSU's Program Associates.

Copies of these papers may be obtained by writing: Strengthening Grant Coordinator, International Agricultural Programs, Waters Hall, Kansas State University, Manhattan, Kansas 66506 (913-532-5715). There will be a charge for selected papers and multiple copies to help defray cost of printing.

Vernon C. Larson
Director

Cornelia Butler Flora
Symposium Organizer

Wendy J. Sheppard
Compiler
International Agricultural Programs

## NOTICE OF NON-DISCRIMINATION

Kansas State University is committed to a policy of non-discrimination on the basis of race, sex, national origin, handicap, or other non-merit reasons, in admissions, educational programs or activities, and employment, all as required by applicable laws and regulations. Inquiries may be addressed to: Director, Affirmative Action Office, 214 Anderson Hall, Kansas State University, Manhattan, KS 66506 (913-532-6220), or Regional Director, Office of Civil Rights, Department of Education, 1150 Grand Avenue, Kansas City, MO 64106 (816-376-2356).

KSU
KANSAS STATE UNIVERSITY

FARMING SYSTEMS IN THE FIELD

NOVEMBER 21-23, 1982

FARMING SYSTEMS RESEARCH SYMPOSIUM

sponsored under the
Title XII Strengthening Grant

by the

Office of
International Agricultural Programs
Kansas State University
Manhattan, Kansas 66506

Symposium Planning Committee:

Cornelia Butler Flora, Chair

Charles Bussing
George Larson
Wendy Sheppard
Meredith Smith
John Wheat
Dwight Wiebe
L. Van Withee

2009 Digital Edition
Kansas State University Digital Library Department

TABLE OF CONTENTS


| | Pages |
|---|---|
| Symposium Objective | 1 |
| Definition of FSR | 1 |
| Organization of the Paper | 1-2 |
| Symposium Agenda | 3-5 |
| Background Papers: | |
| "The Farming Systems Approach to Research" by David W. Norman | 6-19 |
| "Farming Systems Research and the Land Grant System: Transferring Assumptions Overseas" by Cornelia Butler Flora | 20-32 |
| Presented Papers: | |
| "An Overview of On-Going Applied Farming Systems Development Projects: What are Farming Systems and How do They Relate to Development?" by Hubert G. Zandstra | 33-48 |
| "Cropping and Farming Systems Research in Indonesia" by Suryatna Effendi and Jerry L. McIntosh | 49-75 |
| "Tests on Farmers' Fields: The ICARDA Experience" by David Nygaard | 76-98 |
| "Institutional Innovations in National Agricultural Research: On Farm Research within IDIAP, Panama" by Jose Roman Arauz and Juan Carlos Martinez | 99-125 |
| "Developing Technology for Small Farms: A Case Study in Central America" by Luis A. Navarro | 126-145 |
| "Linking Farming Systems Research and Extension to the Farmer-- The Philippine Experience" by Edgardo C. Quisumbling | 146-155 |
| "Relation of Farming Systems Research to Component Research Programs" by William H. Judy | 156-161 |
| "Stratification: An Approach to Cost-Effectiveness for Farming Systems Research and Development" by W. W. Shaner | 162-181 |
| "FSR/E as a Field Methodology in Third World Countries: Its Historical Origins, Current Functions, and Suggestions for Improvement" by Frank S. Conklin | 182-197 |

Pages

"FSR Project Evaluation"
by J. K. McDermott. . . . . 198-205

"Integrating Participants: Farming Systems Lessons from Hawaii"
by Carol J. Pierce Colfer. . . . . 206-214

"Identifying Appropriate Target Populations"
by Patricia Garrett. . . . . 215-225

"Goal Conflict and Incentives Among Institutional Participants"
by Nancy Axinn. . . . . 226-228

"Linking Scientist and Farmer: Re-Thinking Extension Role"
by J. Lin Compton. . . . . 229-240

"Organizational Deficiencies of Technical Assistance Projects
Including FSR/E: Points of Departure for Discussion"
by Frank S. Conklin. . . . . 241-244

"Evaluating Impact in Farming Systems Research and Development
Projects - A Neglected Issue"
by R. H. Bernsten. . . . . 245-263

"Incorporating Nutritional Considerations into Farming Systems Research"
by William P. Whelan. . . . . 264-274

"Translation of Station Experimental Work to Farmer's Field
by Michael D. Schulman. . . . . 275-277

"Long Term vs. Short Term Consultancies: Advantages and Disadvantages
from an AID Mission Viewpoint"
by Myron Smith. . . . . 278-284

"Complementary Aspects of Rural Energy and Farming Systems"
by Richard Morse. . . . . 285-299

Symposium Participants. . . . . 300-304
Symposium Registrants. . . . . 305-311

Presenters Index . . . . . 312
Title Index . . . . . 313-314

## SYMPOSIUM OBJECTIVE

To address issues in the application of Farming Systems Research (FSR) to development projects by examining on-going projects from around the world. The Symposium is aimed at those with a serious interest in the theory and application of FSR and will be of particular value to persons who have, or are planning, field experience.

## DEFINITION OF FSR

The aim of FSR is to increase the welfare of the farm family by increasing its productivity and income. This may be accomplished by obtaining a comprehensive understanding of the farm as an integrated unit of production and consumption. Farming Systems Research involves the identification of cultural, agronomic, environmental, sociopolitical, and socioeconomic constraints to agricultural welfare followed by collaboration of an interdisciplinary team of researchers and farm families in developing and adopting relevant technology. It can also help in influencing the development of relevant policies and support systems. Farming Systems Research implies a two-way flow of knowledge between farm families and researchers.

## ORGANIZATION OF THE PAPERS

Farming Systems Research and Extension has less than a decade of formal recognition and application, yet has been seen by many as a potentially integrative and innovative force in agricultural development. The Symposium was designed to look at accomplishments of FSR&D and issues that are emerging as the approach has become fashionable and more widely applied. The two pre-conference papers attempted to set out the approach, contrast it to other approaches and raise some of the current problems in the FSR&E community.

The Symposium was built around critical examination case studies of Farming Systems Research and Extension that have had a relatively long trajectory of field experience. Hubert Zandstra, who has had a long multi-continent experience with FSR&E, keynoted the conference with a overview of the current state of FSR&E and its potential for the future. Four field experiences were selected for intensive presentation and in-depth discussion by conference participants: 1) The Indonesian/IRRI work, particularly contrasting cropping and farming systems based upon irrigated compared to rainfed rice; 2) The Panamanian/CIMMYT experience in Caisan, looking at opening up new lands with a mixed cropping system; 3) The Syrian/ICARDA attempts to build interdisciplinary teams working with farmers on farmers' field in a crop-based crop/animal farming system; 4) The evolution of the CATIE methodology in Central America, responding to differing ecological and political conditions to work with national research and extension systems.

Specific problem areas of FSR&E were analyzed by the five plenary speakers on the second day: 1) links to the farmers, illustrated by Edgardo C. Qusumbing using the Philippines experience at institutional integration and reorganization as an example; 2) relations to component research programs and the institutional setting, addressed by William H. Judy; 3) the cost-effectiveness of FSR&D and

the use of stratification as an approach to increase it was presented by W.W. Shaner; 4) the contradictions of field methodologies devised in the United States transplanted to developing countries were put forward by Frank S. Conklin; 5) evaluation of FSR&D and the conceptual errors that follow from viewing research and extension as a dichotomy rather than a continuum and the limitations of project time spans in the evaluation process were diagnosed by J. K. McDermott.

The final part of the Symposium was devoted to small group presentations and discussions of yet more concrete issues related to FSR&E. All conference participants were able to attend two one-hour sessions, having first received the position papers of the presenters, and interchange ideas regarding the issues raised. The presenters were chosen for their experience in dealing with those issues on farming systems teams. Issues addressed included 1) integrating team participants, with Carol J. Pierce Colfer; 2) identifying appropriate target populations, with Patricia Garnett; 3) goal conflict and incentives among institutional participants, with Nancy Axinn; 4) the role of extension, with J. Lin Compton; 5) organizing an FSR&E delivery system with Frank S. Conklin; 6) impact evaluation with R. H. Bernsten; 7) incorporating nutritional considerations, with William P. Whelan; 8) translation of station experimental work to farmers' field, with Michael. D. Schulman; 9) long vs. short term project staffing with Myron Smith; and 10) the role of energy in farming systems by Richard Morse.

These papers made clear the necessity of not only systematically examining the farming system and its internal resources, including agronomic and economic parameters, but the containing system as well. Markets for products and sources of inputs, as well as the political institutions in which the farming systems team is located, all were given particular emphasis.

Crucial in these papers were the issues raised from experience, rather than theory. Compared to the Farming Systems Symposium of 1981, it is clear that concrete, applied steps have been taken. That those steps raise and sharpen issues in FSR&E is expected from an approach that is both interactive and participatory.

Cornelia Butler Flora
Symposium Organizer and Editor

## SYMPOSIUM AGENDA

### SUNDAY, NOVEMBER 21

5:00-7:00 pm Registration/check-in, Second Floor Lobby, K-State Union

7:00-8:30 pm Keynote Address, Little Theatre, K-State Union.....Chair: L. VAN WITHEE
(open to public) Department of Agronomy, KSU

*An Overview of On-Going Applied Farming Systems Development Projects: What are Farming Systems and How do They Relate to Development?*
HUBERT ZANDSTRA, International Development Research Center, (IDRC), Vancouver, British Columbia, Canada

8:30-10:00 pm Reception (No Host Bar), Lower Level, Ramada Inn

### MONDAY, NOVEMBER 22

7:30-8:30 am Registration/Check-in, Second Floor Lobby, K-State Union

8:30-9:00 am Opening session, Little Theatre, K-State Union.....Chair: CORNELIA BUTLER FLORA
Department of Sociology, Anthropology, and Social Work, KSU

*Welcome*, KSU President DUANE ACKER
*Symposium Guidelines*, CORNELIA BUTLER FLORA

9:00 am-Noon Presentation of case studies

9:00 am - SURYATNA EFFENDI, Balai Penelitian Perkebunan Sembawa, Indonesia
DAVID NYGARRD, International Center for Agricultural Research in the Dry Areas (ICARDA), Syria

10:00 am - Coffee Break, Second Floor Lobby

10:15 am - JOSE ROMAN ARAUZ, Instituto de Investigación Agropecuaria de Panama, Caisan Project

with

JUAN CARLOS MARTINEZ, International Maize and Wheat Improvement Center (CIMMYT), Mexico

LUIS NAVARRO, Centro Agronómico Tropical de Investigación y Ensenanza (CATIE), Costa Rica

Noon-1:30 pm Luncheon Buffet-informal interest groups, Sunflower Room, K-State Union

1:30-5:15 pm Small group discussion of case studies
(four concurrent sessions repeated four times - to be assigned at registration)
Small Meeting Rooms, K-State Union.....Chair: DWIGHT WIEBE
College of Agriculture KSU

1:30-2:20 pm - discussion groups
2:25-3:15 pm - discussion groups
3:15-3:30 pm - Coffee Break, Second Floor Lobby
3:30-4:20 pm - discussion groups
4:25-5:15 pm - discussion groups

6:30-7:30 pm Banquet, Ballroom, K-State Union.....Chair: VERNON LARSON
Office of International Agricultural Program, KSU

7:30-9:00 pm Presentation, Ballroom (open to public)

*FSR in a Development Context-A Comparison of Florida and Central America*
PETER HILDEBRAND, Food and Resource Economics, University of Florida

TUESDAY, NOVEMBER 23

8:00 am-noon FSR Programs: Relating Research and Practice
Little Theatre, K-State Union

8:00 am – Links to Other Agricultural Development Approaches.....Chair: CHARLES BUSSING
Department of Geography, KSU

*Linking Farming Systems Research and Extension to the Farmer- The Philippine Experience*
EDGARDO QUISUMBLING, Integrated Agricultural Production and Marketing Project (IAPMP), Philippines

*Relation of FSR to Component Research Programs*
WILLIAM JUDY, U.S. Agency for International Development (AID), Washington, DC.

9:45 am - Coffee Break, Second Floor Lobby

10:00 am - Issues in FSR.....Chair: MEREDITH SMITH
Department of Foods and Nutrition, KSU

*Stratification: An Approach to Cost-Effectiveness*
WILLIS SHANER, Industrial Engineering, Colorado State University

*FSR/E as a Field Methodology in Third World Countries: Its Historical Origins, Current Functions, and Suggestions for Improvement*
FRANK CONKLIN, Consortium for International Development (CID), Tucson, Arizona

noon-1:30 pm Luncheon Banquet, Ballroom, K-State Union.....Chair: VERNON LARSON

Presentation

*Introduction*, JOHN DUNBAR, Dean of Agriculture, KSU

*Project Evaluation,*
J. KENNETH McDERMOTT, International Agricultural Development Service (IADS), Washington, D.C.

1:30-3:30 pm Concurrent small group discussions of problems in FSR management
(sign up for two one-hour sessions at registration - eleven concurrent sessions repeated twice)
Small Meeting Rooms, K-State Union.....Chair: GEORGE LARSON
Department of Agricultural Engineering, KSU

a. *Integrating Participants: Farming Systems Lessons from Hawaii*,
CAROL PIERCE COLFER, Hawaii Institute of Tropical Agriculture and Human Resources, (HITAHR), Honolulu

b. *Identifying Appropriate Target Populations*, PATRICIA GARRETT,
Department of Rural Sociology, Cornell University

c. *Goal Conflict and Incentives Among Institutional Participants*, NANCY AXINN,
Bean/Cowpea Collaborative Research Support Program (CRSP), Michigan State University

d. *Linking Scientist and Farmer: Re-Thinking Extension's Role*, J. LIN COMPTON,
Extension and Adult Education, Cornell University

e. *Organisational Deficiencies of Technical Assistance Projects Including FSR/E: Points of Departure for Discussion*, FRANK CONKLIN, CID, Tucson, Arizona

f. *Evaluating Impact in FSR/D Projects-A Neglected Issue*, RICK BERNSTEN,
Winrock International, Morrilton, Arkansas

g. *Incorporating Nutritional Considerations into Farming Systems Research*, WILLIAM WHELAN,
Agricultural Economics and Marketing, Cook College, Rutgers University

h. *Translation of Station Experimental Work to Farmer's Field*,
MICHAEL SCHULMAN, Department of Sociology and Anthropology, North Carolina State University

i. *Long Term vs. Short Term Consultancies: Advantages and Disadvantages from an AID Mission Viewpoint*,
MYRON SMITH, Board for International Food and Agricultural Development (BIFAD), U.S. Agency International Development (AID), Washington, D.C.

j. *Complementary Aspects of Rural Energy and Farming Systems*,
RICHARD MORSE, East-West Resource Systems Institute, Honolulu, Hawaii

k. *Rural Women in West Africa-Key Partners in Economic Development*,
JOCELYNE ALBERT, Program and Policy Coordination/Women in Development, U.S. Agency for International Development (AID), Washington, D.C.

3:30-3:45 pm Coffee Break, Second Floor Lobby

3:45-5:00 pm Wrap-up session on Issues In FSR with
PETER HILDEBRAND, WILLIAM JUDY, WILLIS SHANER
and HUBERT ZANDSTRA.....Chair: JOHN WHEAT
Little Theatre, K-State Union — Department of Animal Sciences and Industry, KSU

*Adjourn*

FSR BACKGROUND PAPERS – Pre-Symposium Circulation

THE FARMING SYSTEMS APPROACH TO RESEARCH

by David W. Norman

FARMING SYSTEMS RESEARCH AND THE LAND-GRANT SYSTEM: TRANSFERRING ASSUMPTIONS OVERSEAS

by Cornelia Butler Flora

# THE FARMING SYSTEMS APPROACH TO RESEARCH

David W. Norman
Kansas State University

## 1. Topics

a. Introduction, objectives, and layout (section 2)
b. Farming system determinants (section 3)
c. Farming systems approach to research (FSAR) (section 4)
d. Attributes of the FSAR (section 5)
e. Methodological problems of the FSAR (section 6)
f. Functions (section 7)
g. Components including funding (section 8)
h. Boundaries (section 9)

## 2. Introduction, objectives, and layouts

a. The farming systems approach to research is a product of the 1970s. It developed due to frustration over partial or complete failure of other approaches in developing technology relevant for farming families located in relatively unfavorable environments.

b. There is considerable confusion over how a farming system is defined and what the farming systems approach to research (FSAR) is. It is important to have a consensus on what these are in order to address the central objectives of this paper. At the moment, the term FSAR is used too loosely.

c. The FSAR is still evolving and, therefore, conventional wisdom for solving methodological and implementation problems has still not developed. However, some general guidelines are emerging, but these are likely to be modified in the light of further experience.

d. After defining what a farming system is and describing what constitutes the FSAR and its attributes, the foundation is laid for a consideration of the various other topics assigned to this paper: methodological problems, functions, components, and funding, and boundaries. These topics, however, are not mutually exclusive. Therefore, there is some overlap in the discussion.

## 3. Farming systems determinants

a. In developing countries, there is considerable overlap between the unit of production and the unit of consumption. Thus, the means of livelihood and household are intimately linked and cannot be separated (Figure 1).

b. A farming system adopted by a given farming household results from its members, with the managerial know-how, allocating the three factors of production, i.e., land, labor, and capital, to which they have access, to the three processes (crops, livestock, and off-farm enterprises) in a manner which, within the knowledge they possess, will maximize the attainment of the goal(s) for which they are striving.

c. The farming system is determined by the environment in which the farming family operates. The "total" environment in which it operates can be divided into the technical (natural) and human elements.

d. The technical element reflects what the potential farming system can be and, therefore, provides the necessary condition for its presence. The technical element can be divided into:

(1) Physical factors-water, soil, solar radiation, temperatures, etc.
(2) Biological factors-crop and animal physiology, disease, insect attack, etc.

Technical scientists have been able to modify the technical element to some extent.

e. The human element has often been neglected in traditional research approaches to development of improved technologies, which accounts for their often being rejected or, at best, being differentially adopted, thereby resulting in an inequitable distribution of benefits. The human element, providing the sufficient condition for the presence of a farming system, determines what the actual farming system will be--being a subset of the potential defined by the technical element.

f. The human element can be divided into two components or groups of factors. The exogenous factors-the social milieu in which the farming household operates-are largely out of the control of the individual farming household, but will influence what its members are able to do. They can be divided into three broad groups:

(1) Community structures, norms, and beliefs.
(2) External institutions or support systems. This is often provided by government, both on the input (extension, input distribution) and product (direct and indirect intervention) sides.
(3) Miscellaneous influences-location, population density, etc.

On the other hand, endogenous factors-land, labor, and capital, along with management-which are under the control of the individual farming household, can be used by them to derive a farming system consistent with their goal(s) subject to the boundary conditions laid down by the technical element and exogenous factors. The endogenous factors can, under certain circumstances, be complemented and supplemented in quantitative and qualitative terms through the influence of exogenous factors-such as capital through a credit program, management via extension, etc.

4. <u>Defining the farming systems approach to research (FSAR)</u>

a. The primary aim of the FSAR is to increase the overall productivity of the farming system-therefore, hopefully the welfare of individual farming families-in the context of the entire range of private and societal goals-given the constraints and potentials imposed by the determinants of the existing farming systems.

b. Increased productivity is achieved through two types of developmental strategies :

(1) Farming systems research (FSR)-involving the development and dissemination of relevant improved practices (technologies).
(2) Farming systems perspective (FSP)-involving influencing the development of relevant policies and support systems (external institutions.

c. Both developmental strategies have a "micro to macro" or "bottom-up" orientation compared with the more "top-down" or "macro to micro" orientation of research work that starts at the experiment station or in the upper echelons of planning ministries.

d. Given the right institutional setting and linkages, both FSR and FSP are possible. However, because FSR programs have usually been located in agricultural research institutes-primarily crop oriented-often with poor linkages to planning or policy-making agencies, the FSP has usually not been operative. Thus, the support systems have been considered parameters (implying a submissive approach to them on the part of the FSR team) rather than variables amenable to manipulation (implying an interventionist approach on the part of the FSR team). An interventionist approach permits a wider range of possible improved technologies to be considered in the research process.

e. The term FSR has often been used very loosely. There are programs called FSR that are not FSR, and there are programs not called FSR that are indeed FSR. The following characterizes FSR:

(1) The farm, as a whole, is viewed in a comprehensive manner.
(2) The choice of priorities for research reflects the initial study of the whole farm.
(3) Research on a farm sub-system is legitimate FSR, provided the connections with other sub-systems are recognized and taken into account.
(4) Evaluation of research results explicitly takes into account linkages between sub-systems.

Using the above characterization, as long as the concept of the whole farm and its environment are preserved, not all factors determining the farming system need to be considered as variables -some may be treated as parameters. Therefore, FSR may be called FSR "in the small" (low ratio of variables to parameters) or FSR "in the large" (high ratio of variables to parameters). Incorporation of FSP into FSR increases the ratio of variables to parameters. However, methodological and implementation issues become more complex as the ratio of the variables to parameters increases. In addition to the methodological issue, the scope of the FSR program will be partially determined by the mandate of the institution in which it is located, the effectiveness of linkages with other institutions and agencies, resources available, i,e., time skill, finances, etc.

f. As well as FSR programs being differentiated on the basis of the ratio of variables to parameters, they can also be classified as follows:

(1) "Upstream" types of FSR programs have a developmental orientation and usually do not provide results for immediate adoption by farming families. Perhaps more aptly called resource management research, "upstream" FSR programs involve using a systems approach to provide prototype solutions on experiment stations to major constraints to crop or agricultural improvement, e.g., watershed management, intercropping, etc. Along with results from commodity research programs-reductionist research-they contribute to the body of knowledge (Figure 2) and are available for feeding into the "downstream" FSR programs.

(2) "Downstream" types of FSR programs, which are the main concern of this paper, have an applied orientation and aim at developing and introducing strategies that will improve the productivity of farming systems for target groups of farming families now and in the short-run. This requires selectively drawing upon available information, i.e., body of knowledge in Figure 2, in the process of designing practices or recommendations for a particular farming system on the basis of an analysis of the constraints of that system. Therefore, recommendations are produced which are suited to a specific local situation. This involves working directly with farmers, i.e., on-farm research, and, as a result, reducing to a minimum work on the experiment station.

g. There are four stages in applied or "downstream" FSR (Figure 2):

(1) The descriptive or diagnostic stage in which the actual farming system is examined in the context of the "total" environment-to identify constraints farmers face and to ascertain the potential flexibility in the farming system in terms of timing, slack resources, etc. An effort is also made to understand goals and motivation of farmers that may affect their efforts to improve the farming system.

(2) The design stage in which a range of strategies is identified that is thought to be relevant in dealing with the constraints delineated in the descriptive or diagnostic stage. Heavy reliance at this stage is placed on obtaining information from the "body of knowledge."

(3) The testing stage in which a few promising strategies arising from the design stage are examined and evaluated under farm conditions to ascertain their suitability for producing desirable and acceptable changes in the existing farming system. This stage consists of two parts: initial trials at the farm level with joint researcher and farmer participation (researcher managed), then farmers' testing with total control by farmers themselves (farmer managed).

(4) The extension stage in which the strategies that were identified and screened during the design and testing stages are implemented.

In practice, there are no clear boundaries between the various stages. Design activities, for example, may begin before the descriptive and diagnostic stages end, and may continue into the testing stage, as promising alternatives emerge during the trials at the farm level-where farmers and researchers interact directly. Similarly, testing by farmers may mark the beginning of extension activities.

5. Attributes of the FSAR

a. The objectives of the farmer (farming family) are directly incorporated into the research process. The farmer is the central unit in the research process, being directly involved in the description, testing and extension stages. Involvement of farmers gives them a "voice" in the research process and ensures the use of evaluation criteria relevant to them. For the farming family, evaluation criteria for the adoption of improved practices can be divided into the following groups; although it should be emphasized they are not mutually exclusive:

(1) Necessary conditions determine whether the farmer would be able to adopt the improved practices. Such conditions would include technical feasibility, social acceptability, and compatibility with external institutions-that is, support systems.
(2) Sufficient conditions determine whether the farmer would be willing to adopt the improved practices. Obviously the necessary conditions will be influential in determining this willingness. Sufficient conditions will include compatibility of the improved practices with the goal(s)-self-sufficiency, profit maximization, etc.-of the farming family and of the farming system they currently practice.

b. Efforts are made to incorporate community and societal needs into the FSR process by trying to ensure a convergence between private (usually short-run) and societal (usually longer run) interests. Examples of possible conflicts would be where satisfying short-run needs of individual farming families would result on long-run societal costs in terms of degradation of the natural resource base, increased inequalities in welfare distribution, etc. It is necessary to develop improved strategies that will avoid such conflicts.

c. The FSR approach, by including farmers, taps the pool of knowledge in the society and enables research and hence developmental strategies to build upon the good points of the present farming systems, while at the same time minimizing the time spent in "rediscovering the wheel"-for example, the value of intercropping.

d. FSR recognizes the locational specificity of the technical and human (exogenous and endogenous factors) elements. This requires disaggregating farming families into homogenous subgroups (recommendation domains) and developing strategies appropriate to each. Farming families in a particular subgroup will tend to have similar farming activities and to include similar social customs, similar access to support systems, comparable marketing opportunities, and similar present technology and resource endowment.

e. The whole farm perspective of FSR compels the adoption of an integrative function which increases the potential of exploiting complementary and supplementary relationships between resources and enterprises, and the derivation of solutions compatible with the needs and capacities of farming families. The farming systems farmers practiced traditionally recognized such relationships-for example crops and livestock, staggered planting dates, etc. To ensure that the integrative and beneficial relationships are adequately considered and exploited requires a multidisciplinary team-both technical and social scientists-working

together at all four stages of the research process.

f. The process of FSR is recognized as being dynamic and iterative with linkages in both directions between farmers, research workers, and funding agencies, rather than simply the presence of forward linkages characteristic of the “top-down" approach. The iterative characteristic can improve the efficiency of the research process through providing a means to fine-tune improved technologies to a specific locale.

g. Finally, FSR complements, and does not compete with, other research approaches. The complementarity is illustrated through FSR contributing in two ways:

(1) Fine-tuning through adaptive testing at the farm level those technologies developed on experiment stations through "upstream" SR and the more conventional reductionist approach (both contribute to the "body of knowledge"). Successful testing gives rise to successful dissemination (all other things being equal), resulting in improvement of farming families' welfare.

(2) Failure under adaptive testing at the farm level results in closer specification of requirements for improved technology development that can be fed back to experiment station based research programs outside the FSR program itself. Hopefully, this will contribute to the development of improved technologies that will improve the welfare of farming families in the future.

6. Methodological problems of the FSAR

a. Due to the fact that the methodology for undertaking "downstream" FSR is still going through a period of evolution, a large variety of methodological issues require resolution. Not surprisingly perhaps, there are often considerable differences in opinions as to how severe they are and how they should be dealt with. Some of the most frequently mentioned methodological issues follow.

b. How holistic should FSR be? As mentioned earlier, the methodological problems increase as the FSR program becomes more holistic, i.e., the ratio of variables to parameters becomes higher. Also stressed earlier was the fact that the present state of the art of undertaking FSR means that most current work is on the crop process and is largely confined to development of improved technologies. Practical problems also restricting the scope of "downstream" FSR are the mandates of institutions in which they are located, i.e., usually technical crop research institutes, poor or weak linkages with other research institutions, and policy-making and farmer contact agencies. Related to the question of how holistic "downstream" FSR should be is the issue of whether the policy-institutional environments should be treated as parameters or variables. Increasingly inFSP, it is being suggested that these might be treated as variables subject to manipulation, as suggested earlier. This micro-macro link is important in maintaining the viability of "downstream" FSR in the long-run through the added dimension it gives to creating conditions conducive to improving the productivity of farming systems and therefore hopefully the welfare of farming families.

c. What needs or constraints are to receive focus in the research process? Should they be those articulated by faming families, i.e., felt needs, those scientifically ascertained by research workers, or those reflecting the needs of society? As discussed earlier, criteria used in developing improved strategies should reflect the needs of farming families, providing they are not incompatible with the needs of society, e.g., there is not a decline in soil fertility, nutritional levels, increasingly inequitable income distribution, etc. Strategies developed need to ensure convergence between short-run private interests and those of the society in the long-run. Although there is, in principle, agreement with the above, there is often disagreement as to how societal interests can be incorporated practically into "downstream" FSR. The problem of doing this relates to the methodological complexity of their incorporation and the time that would be required in deriving societal impact evaluations.

d. The needs or constraints that are identified may be technical, economic or socio-cultural in nature. What approach should be used in dealing with them? The two approaches generally used are:

(1) Accepting the constraint and developing strategies that exploit the flexibility that exists in the current farming system while at the same time not further exacerbating the constraint. Sociocultural constraints should not generally be broken.

(2) Developing strategies that will overcome the constraint. The decision as to which approach to use usually depends on the constraint severity, flexibility that exists in the current farming system, availability of potential improved strategies either to break the constraint or to exploit the flexibility, compatibility with societal goals, etc.

e. Is it necessary for "downstream" FSR to be expensive? It is viewed by some to be expensive because of its locational specificity and, therefore, the need to focus on limited numbers of farmers. The expensive nature is emphasized because of the opportunity costs of neglecting other farmers. Thus, the quest for minimizing costs in the research process is a major issue. Considerable controversy exists concerning the degree to which costs can and should be reduced, and the ways in which they should be reduced. In general three approaches are being used to try to minimize costs:

(1) Seeking ways to reduce time and resources required for moving through the four research stages-methods used should be based on the degree of understanding that is necessary. Can this be done with base data analysis plus an informal exploratory (sondeo) survey and a one-shot formal survey? Or is a detailed twice weekly formal survey required for a period of one year? Can modeling techniques help improve understanding-or does this come at too high a cost? In the testing stage, should farmers be selected that are the better farmers, most cooperative farmers, or simply representative farmers? Representative farmers may not, for example, be so cooperative, thereby reducing the efficiency and effectiveness of dialogue and the timely conclusion of the testing stage. Considerable controversy still exists concerning the way in which these and other questions should be resolved in the interests of minimizing costs and time.

(2) Finding ways to maximize the return from the location specific nature of “downstream" FSR by determining the transferability of the results to other similar "total" environments. Introducing some flexibility into the improved practices increases the potential of transferability, but this may come at some cost in terms of the potential level of return. Is this, or is this not, desirable? Controversy exists with respect to this.

(3) Seeking the best of readily available solutions-that is "better, but not necessarily best" or "non-perfectabilitarian." How much fine-tuning should there be, thereby extending the testing stage?

f. In terms of developing improved practices (technologies), should emphasis be placed on single trait innovations, which may preclude the exploitation of possible complementary or synergistic effects between the various components in packages of improved practices? In theory the former would be desirable, but in practice the latter are much more common. A possible compromise is to design and develop packages of improved practices that permit, in an explicit manner, a stepwise approach to the adoption of the various components of the package.

7. Functions

a. The location and linkages of the FSAR program will determine whether:

(1) FSR, or helping to generate relevant improved technology, is the primary focus.

(2) FSP, or helping to develop relevant agricultural policies/support systems, is the primary focus.

(3) If linkages are good between research and planning/implementation institutions, some mix between the two may be possible, i.e., FSR plus FSP = FSAR.

At the moment, the major thrust is on developing relevant improved technologies for the crop sub-system. This is, in part, because most FSR-type programs are located in agricultural research institutes whose mandates revolve around crops.

b. FSAR-type programs help generate and communicate information in the following ways:

(1) Through providing a means for farmers to communicate their needs to researchers (FSR) and planning implementation agencies (FSP)-which has often been lacking in the more conventional "top-down" approaches.

(2) Through bringing about linkages between farmers, extension personnel, and researchers (FSR), and farmers, extension personnel, and planning/implementation institutions (FSP).

c. FSAR-type programs provide a "practical component" in the on-the-job training of research, extension, and planning personnel, In fact, much of the skill obtained to date in FSAR-type activities has been derived from longevity in the field rather than through formal training programs. Although formal degree training is not available in this general area, short courses in the interdisciplinary characteristics of FSAR-type activities are being developed at a number of international (CIMMYT, IRRI), regional (CATIE), and national (ICT) institutes.

d. In these various functions, FSAR-type activities perform a facilitating or integrating role rather than initiating role. Therefore, these types of activities should not come right at the beginning of the development process unless funding agencies are willing to accept a long gestation period in terms of achieving results. For example, FSR programs are likely to have low immediate returns if the "body of knowledge" (Figure 2) is poorly developed. FSR activities are not a substitute for experiment station based commodity research. Such national research programs can benefit from linkages with CRSPs and IRACs (provided understandable inhibitions are overcome)-which can provide expertise in deficient areas and provide critical masses of staff and resources for looking at complex problems ("upstream" or developmental FSR).

8. Components

a. Because of the locational specificity of FSAR-type activities, the future-particularly of “down-stream" or applied activities-must lie within national programs.

b. Problems within national programs that make introduction of FSR activities difficult include:

(1) Staff constraints:
- relative immobility of staff within national settings sometimes discourages changes and encourages maintenance of the status quo, therefore resulting in opposition to "new" FSR programs.
- interdisciplinary FSR activities require the interaction of both technical and social science disciplines-the latter are usually lacking in technical agricultural research institutes in Africa.

(2) Organizational/operational constraints:
- national research programs used to be organized along discipline lines which have more recently given way to programs organized along commodity lines.
- however, FSR programs involve crossing both discipline and commodity lines.

(3) Research resource constraints:
- financial and manpower constraints are both common in national settings.

(4) Locational specificity of applied ("downstream") FSR programs constraint. This constraint and the fact that FSR programs work with limited numbers of farming families (hopefully representative of much larger numbers) add to the perception of some of the expensive nature of such research. In arriving at such conclusions, sunk costs involved in developing experiment stations, and low returns from other past research endeavors, are likely to be heavily discounted or even ignored. Because of the complementarity of "downstream" FSR activities and other research approaches, there appears to be little value in comparing the benefit-cost ratios of different research approaches. However, a challenge does exist in finding ways to minimize the cost of "downstream" FSR activities, a topic that was discussed earlier (see section 6(e)).

c. Implications for instituting the components of an FSR program in a national setting are, therefore, as follows:

(1) Be minimally disruptive in instituting an FSR activity within national programs. It is not necessary, for example, to call it FSR if this is politically unpalatable, while, in order to encourage intra-institutional linkages and cooperation, it is probably not always desirable -initially at least- to have a separate unit for FSR. Improved possibilities for support and commitment are likely to arise if it is grafted onto an existing administrative unit, e.g., agronomy.

(2) Staff and funding limitations usually require initial "pump priming" through:

- support from donor agencies. This will mainly have to come from public rather than private sources. Funds and personnel from the latter source are not likely to be forthcoming for institutionalizing an FSR-type program where the gestation period is likely to be lengthy in terms of getting results.
- support through developing links with relevant IARCs that are developing expertise in "downstream" FSR.
- recourse to advice and help from a central core group of expertise on FSR activities (such as AID in considering providing funds for at present) and Title XII Strengthening Grants in the U.S. universities which are focusing on FSAR-type activities.

(3) Although strong arguments can be made for locating FSR teams within current institutions, attention needs to be paid to developing inter-institutional linkages, thus improving the possibilities for effective FSR activities. Chances for such effectiveness can be increased through, for example:

- obtaining some manpower and financial commitments on the part of extension and planning/ implementation agencies. The involvement of the former in the research program can potentially help mend the rift that often exists between research and extension, while the latter provides the opportunity for the inclusion of an FSP and the possible source of agricultural economists, often lacking in technical research institutes.
- arranging linkages, perhaps essentially of an informal nature, with institutions/organizations with expertise in "downstream" FSR. Since "downstream" FSR is still evolving, there are many methodological issues that still remain to be satisfactorily resolved.

(4) If an FSP is to receive priority in FSAR-type programs -a priority that is currently rare- then the logical institutional location of such program is within a development project, extension program, or planning unit.

9. <u>Boundaries</u>

a. As has been emphasized earlier, the major activities of "downstream" FSR programs in the future must be within national programs, although linkages with external agencies and expertise will be important in improving the effectiveness of national programs, particularly in solving methodological problems, transferring results across national boundaries in areas with similar "total" (technical and human) environments, etc.

b. Experiment station based research programs are, currently, usually organized along commodity lines and have a national focus.

c. Two possible ways exist for organizing "downstream" FSR-type activities:

(1) "FSR in the small" emphasizing a couple of products throughout the country.
(2) "FSR in the large" where all products (processes) are considered as in a regionally focused program. (Such a program could still be "FSR in the small" where only the major products are focused on.)

Approach (2) is currently being emphasized in preference to approach (1), with regions being either defined ecologically (more relevant for an FSR program), or administratively (more important where an FSP emphasis is expected), or some compromise between the two.

d. In setting up boundaries for FSAR-type programs, it is essential that effective linkages are maintained between:

(1) The various regionally focused FSAR programs.
(2) The regionally focused FSAR programs and the experiment station based research programs, extension, implementing and planning institutions.

This can be facilitated through meetings, visits of staff to other programs, etc.

10. Conclusion

FSAR-type activities are not a panacea. They complement and help integrate and improve the pay-off of other activities through providing a "bottom-up" approach. The decision whether to introduce FSAR activities is not an either-or decision, but rather one that can help improve the performance of other on-going activities.

FIGURE 1

Schematic Representation of Some Farming System Determinants

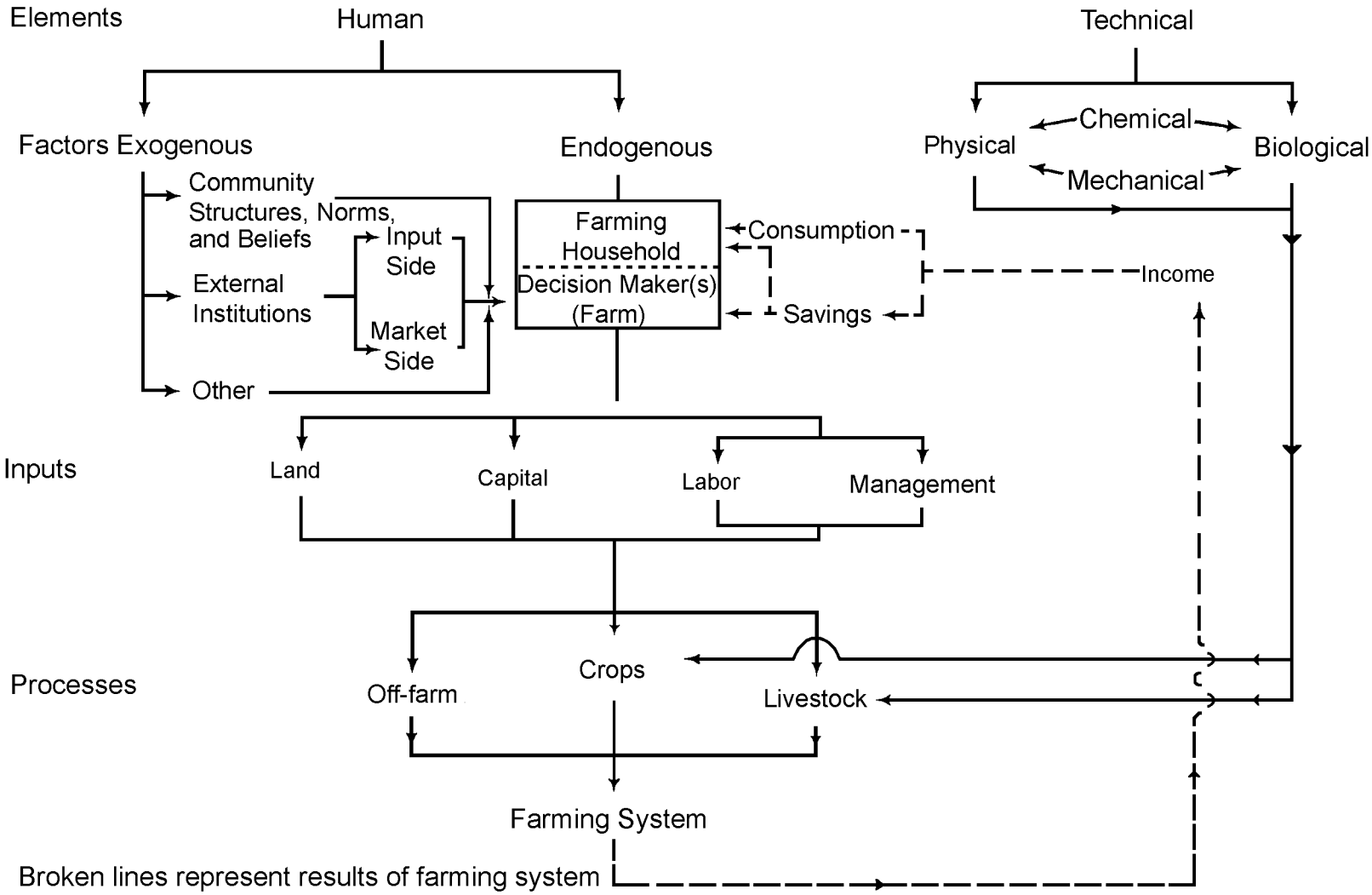
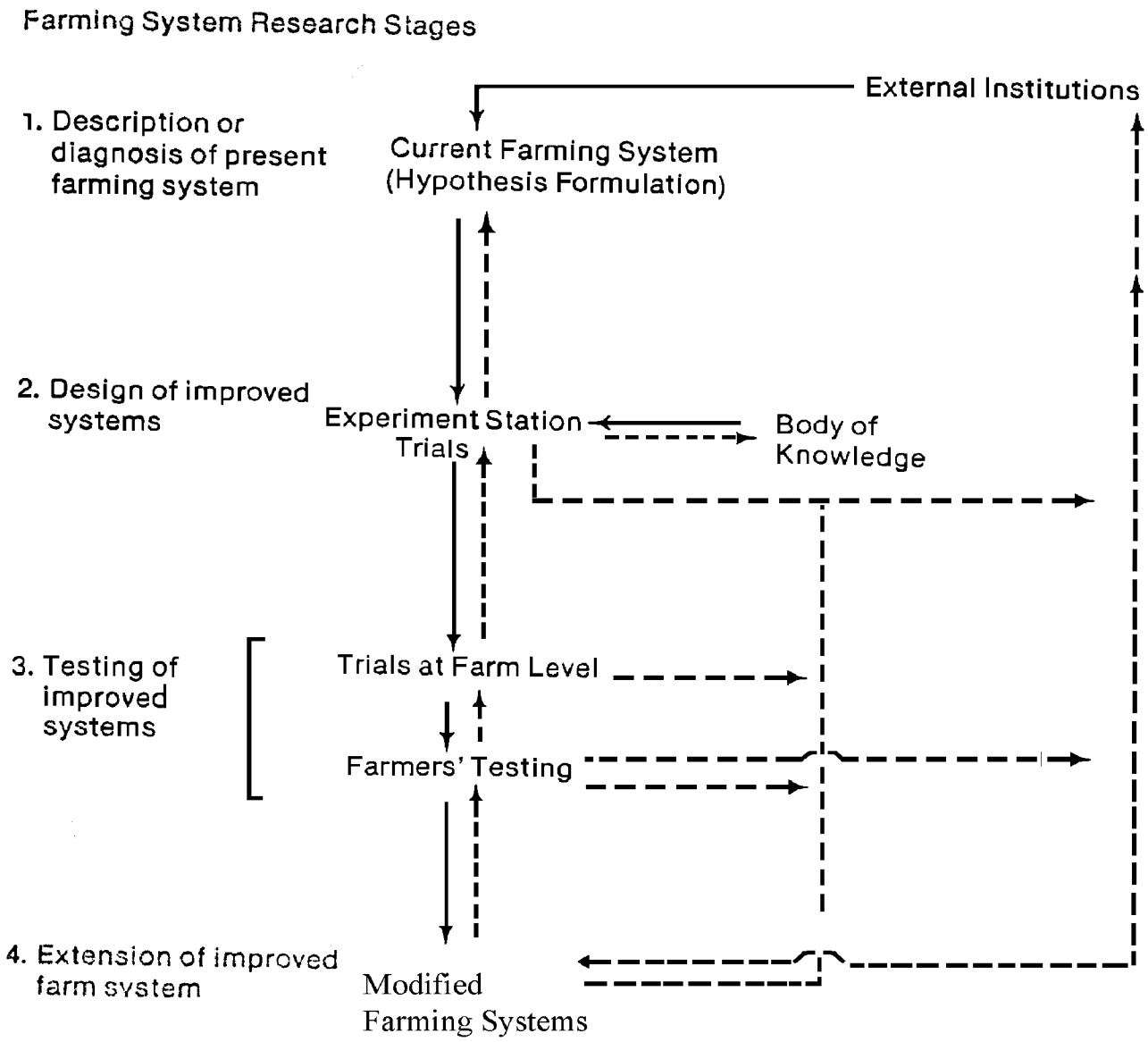


FIGURE 2

Schematic Framework for Farming Systems Research



# FARMING SYSTEMS RESEARCH AND THE LAND-GRANT SYSTEM: TRANSFERRING ASSUMPTIONS OVERSEAS

Cornelia Butler Flora*

American agriculture owes much of its development and strength to the land-grant system. This system, based on the Jeffersonian ideal of participatory democracy, allows for members of the farm households who produce the bulk of our food and fiber to relate directly to researchers and extension agents to make their needs known. Farmers' expressed needs then become the basis for developing technology and getting it out to the farm, in order to increase productivity and raise the level of living of farm families.

That model, so successful in the United States, has been built on a number of conditions peculiar to the United States that we do not make explicit. These conditions, which we take for granted, are both necessary and sufficient for our system of research and extension to function well.

Agricultural development has often by-passed the limited resource farmer. Even major technological breakthroughs in productivity, such as the "miracle" varieties of wheat and rice, tended to accrue benefits to large farmers (Pearse, 1980). Food imports are increasing in many middle-income countries, sapping them of much needed foreign exchange, while in low-income countries, food imports have not decreased and food aid remains a substantial portion of their food imports (World Bank, 1981: 102-103). Can the problems of small farm agriculture, which produces the roots, tubers, and grains (wage foods) that are the basic diet of most people in the world, be met by transferring U.S. institutional arrangements (even more than U.S. technology) to developing country settings?

When we begin to try to work with national governments to improve overseas agriculture through research and extension-particularly research and extension aimed at the limited resource farmer -we have to go back and look at the conditions of agricultural development in the United States. We must better understand what went on in the United States in order to know what we need to do to help in developing a system of research and extension relating directly to people's needs.

## Conditions Contributing to U.S. Success

In the United States, the mandate for research and determination of who would control that research came through a political process. The laws setting up the land-grant system and structuring the Department of Agriculture came, in part, from the pressure of the farmers themselves, who understood the need for improving farming processes in order to better their own lives (Rothstein, 1978). The system was not imposed by colonial powers nor modeled after one already in existence in a more developed country. An organized and vocal constituency for research and extension developed-the first condition contributing to the successful development of U.S. agriculturally-oriented institutions.

---

*This paper is adapted from one presented at the 18th Annual Conference of the Association of U.S. University Directors of International Agricultural Programs, Lincoln, Nebraska, June 8-10, 1982.

Further, that farmer constituency was organized both in separate pressure groups (such as the Grange and the Farm Bureau) and in political parties (the Democrats in the South and the Republicans in the Midwest). Often white, male farmers were elected to the legislature and to Congress in order to articulate their needs directly to the fund providers as the land-grant system was established.

This process is very different from that experienced by the "target" farmers in development projects in Third World countries. There, limited resource farmers are often marginal to the political process. Such farmers control few funds and have little organization at a national level. Their political clout is negligible as a result. The mandate for the program and the funds for the research and extension aimed at limited resource farmers often come from outside donors concerned about macro problems of food production. While such outsiders from either international agencies or from the national capital city try to understand the farmers, their understanding is often incomplete because of the top-down nature of the programs.

Active political participation to influence policy in one's own immediate self-interest on an issue-by-issue basis is not always possible among Third World limited resource farmers. Indeed, such issue mobilization, when it occurs, is often blocked directly by governments. Such movements then are either radicalized or repressed, and often both. (The history of the National Peasant Users' Association in Colombia is an example (Bagley and Botero, 1978).) Lack of economic power translates into lack of political power. Upsetting the status quo by demanding participation in program formulation-which influences resource distribution-is often seen by those in power as revolutionary and threatening.

A second condition that we implicitly assume is the unity of goals between researchers and farmers. In the United States, we knew clearly what the goals and objectives of the farming household were. One of the reasons was that they were "us". Researchers and extension agents-the employees of the land-grant system-came from farming backgrounds; their parents were farmers and often they themselves continued to farm (Busch, Lacy and Sachs, 1980). Goals and objectives never needed to be much discussed because they were implicit in the frame of reference and upbringing of the researchers, the extension agents, and the users of research-all of whom shared the same social background and the same experience in practical agriculture. Almost all of the first extension agents were farmers themselves, and even today, some land-grant faculty are part-time farmers.

Contrast this now to developing countries. Third World limited resource farmers often are not able to send their sons and daughters to grade school, much less to college or graduate school to learn agricultural technology. Young men or women from marginal, two-hectare farms are very unlikely to attend the university, and certainly when they do, few of them will wish to return to the rural areas. (A parallel in our country can be drawn in looking at the dearth of black agricultural scientists. Few black youth who escaped the back breaking work of chopping cotton had much desire to pursue agriculture when they had a chance to choose a different career.) Instead, those who get out into the formal agricultural research and extension system tend to be people of urban backgrounds, often from upper class or elite origins. These people, if they have been on a farm at all in Latin America, have been on their family finca or hacienda, where they had a chance to ride horses and enjoy a pastoral weekend of relaxation. But they were never engaged in the hard, physical labor of agricultural production. Through training in leading U.S. universities, Third World researchers' goals tend to develop as scientists, not as farmers. Their reference group will more likely be First World

professional journals rather than limited resource farmers. Differences in experience in practical agriculture means that the kind of research developed will not necessarily be that which corresponds to the needs of the everyday farmers, particularly those limited resource farmers who produce most of the wage foods-the subsistence crops most of the poor population eat in the Third World.

A third phenomenon in the United States that does not exist in many developing contexts is valuing the combination of mental and manual labor. This value stemmed from the conditions of production favoring freeholder agriculture. One of the reasons the farming lifestyle has been valued in the United States is that the farmer controls the means of production-no one tells the farmer what to do, as one would an employee (Kelly, 1979). That is to say, the farmer owns the land, or at least has title to it, even if still paying off family debts. The farm family provides the work and the farm family reaps the profits from that work, or shares the losses if there is a bad crop year. Thus, in the U.S., we see nothing intrinsically wrong with people getting their hands dirty and sweating in the field because it is understood that the same people who do the dirty manual work also make decisions about planting, harvesting, purchasing inputs, and marketing. They also get to keep any profits generated.

How different this is from many developing countries of the world. Land is much less equally divided. (See, for example, Barraclough, 1973, for Latin America; despite land reform, land distribution remains much the same- the large farms have simply become more capital intensive (Barsky and Cosse, 1982:52-56).) A few landowners have a lot of land that is often farmed by sharecroppers. Furthermore, even in places in Africa where land is more evenly divided, the people who make the final decisions about production often are in urban areas, not in the rural areas doing the manual work (Clarke, 1980; Bernstein, 1977). The mistaken idea that getting your hands dirty and sweating is inappropriate for gentlemen and ladies was introduced by colonial masters who, because of their greater relative wealth, were able to hire the local population to do the manual work-defining it was inappropriate for those in command. Education became a tool for getting away from manual work, not for doing it better.

A fourth condition implicit in the development of the U.S. farm economy was that of the complete farm family-a husband and a wife sharing management, labor, and land ownership (once women gained property rights). The U.S. farm family is often a decision-making and management unit, with the wife keeping the farm records and discussing purchasing and marketing decisions with the husband. Further, the unit of production was highly intertwined with the unit of reproduction-the household. It was difficult to separate the accounting units of the home and enterprise, although all decisions involved allocations between them. (See Weber, 1947:275-280, on the implications of that lack of separation for becoming part of a modern economy) Division of labor by sex existed on U.S. farms causing the man to be defined as the farmer and the woman as home maker. But women's labor has been important and, although rural-urban migration in the United States had reduced the number of young people on farms, the couple remains on the land.

What a contrast this complete, complementary farm family is to limited resource Third World farms. Women are often active in all aspects of food production, both by custom and by necessity, as temporary migration by males to participate as wage laborers in construction, extractive industries and cash crops for export feminizes subsistence agriculture (Deere and Leon de Leal, 1980). In the Third World, division of labor by sex has also been traditional. Even when women were the agriculturalists, men provided complementary labor, such as clearing the fields of plowing. Temporary male migration upsets the traditional balance.

A fifth condition that has aided the development of U.S. agriculture has been the ability of the larger economy to absorb the non-competitive farmers in other employment sectors. Thus, our research and extension efforts have been able to focus on the more successful large, family farms. This "solution" for marginal farmers is unacceptable in much of the Third World because other opportunities to generate family income are not available. Further, because of price and other incentive structures, food production in the Third World is generally carried out by these limited resource farmers, while the modern farmers are large and engaged in export agriculture.

A sixth condition that exists in the United States, but not in Third World countries, is the close cooperation between private and public sectors in adapting and distributing technological innovation. The relatively high purchasing power of U.S. farmers has led to the development of a strong private sector in rural areas that forms the link between experiment station and farmer. Private enterprise has had a long history of cooperation with public researchers in variety development, for example, focusing on adaptive breeding, releasing and maintaining breeder seed varieties, and producing high-quality plant seed and distributing it to farmers (Grossman, 1982). This division of labor between private and public sectors has led the private sector to be that most closely responding to (and attempting to form) farmers' needs. The International Maize and Wheat Improvement Center (CIMMYT) researchers have pointed out how, in developed countries, the agribusiness sector integrates research results into effective technologies. "Developing countries rarely have these mediating entities, and the bureaucracies and incentive systems of public institutions do not encourage researchers to play this integrative role" (CIMMYT, 1981, p. 10).

## The Contributions of Farming Systems Research

In our agricultural development work overseas, we must continually become more aware of the conditions we assume exist and compare them to the conditions that actually do exist. One tool that has evolved in the past decade to help in this-a tool that takes us back to some of the early research and extension in the U.S. land-grant system-is Farming Systems Research and Development (FSR&D).

What is FSR&D, and how can it help us counteract the biases arising from assuming that the conditions in our own cultural setting exist all over? FSR&D is aimed at increasing the agricultural welfare of the farm family by understanding the whole farm in a comprehensive manner. The integrated demands of the unit of production/reproduction for alternative sources and uses of land, labor, capital, management, and equipment in the production system are related. The totality of crops and animals, and their by-products, for both subsistence use and for market, as well as temporary off-farm employment, are included. FSR&D involves formal, interdisciplinary problem identification in participation with the farm family, taking into account the needs of society as a whole. In collaboration with farm families, appropriate technology is determined (usually from available technology) and evaluated on their fields under their constraints. FSR&D implies a two-way flow of knowledge between farm families and researchers. (See Shaner, et al, 1982, for an extensive development of this definition.)

Thus, farming systems research is, in essence, an attempt to use social and production sciences together to approximate the conditions of research and extension that exist in our country because of the relative economic equality in our society and the relative equality and similarities in background of farmer, researcher, and

extension agent in the U.S.-conditions the cannot be assumed to exist in the Third World. FSR&D provides a proxy for political mobilization and pressure, a method of articulating the various goals of the participants (development agency, farm family, nation state), a combination of mental and manual work in carrying out the experiments, and awareness of labor and management availability by sex and age, and an unwillingness to define a farmer who is disadvantaged in relation to land or capital as "inefficient."

Farming systems research tries to identify the logic of the farming practices the farmer actually uses. In the U.S. setting, the logic of why a farmer does something is rather clear to the researchers because the researchers themselves have used those practices, and perhaps grown up with them over time. The researcher in the United States intuits the problem and is able to bring about a solution. FSR&D provides explicit problem identification for cooperative problem solving.

Farming systems research treats motivations and deals explicitly with goals-factors that we assume are equivalent between researcher, extension agent, and farmer in our society, but which may differ radically in developing societies.

The activities farming systems research looks at are broad-perhaps broader than they currently are on farms in the United States. They include crop production and livestock production-these of course are similar-as well as the processing, storage, and marketing of crop and livestock products. Off-farm and non-agricultural activities must be considered as well, particularly as they impact on agricultural activities. There is a trend in U.S. agriculture toward part-time farming-another set of factors impacting on goals, production and profit for the farm family.

As we have shifted to monoculture in U.S. agriculture, more and more processing and storage has taken place off the farm. This is true despite the move toward building on-farm storage capacity that began in the '50s. Combines do some grain processing, but on Third World small farms, processing is much less mechanized and much more likely to be carried out on-farm.

FSR&D determines what constraints are present in the society and tries to work within them. If that cannot be accomplished (and generally farmers have been found to be relatively efficient give the inputs available), FSR&D can only be successful if it coincides with the institutionalization of provision of new inputs or marketing structures.

Ready availability of recommended inputs, assumed in the United States, can not be taken for granted in an FSR&D project. Because the United States is a primary manufacturer of fertilizer, herbicides, machinery, and petroleum, it does not have the import problems that create blockages for inputs in developing countries. Problems of tariffs, exchange rates, and procurement of hard currency here are not the obstacles to getting technology that they are in the Third World. (Interestingly, there seems to be no research on risk in farm decision-making when uncertain supply of a factor of production is also a decision variable (Anderson, et al, 1982:425). Risk avoidance has looked at the risk involved in natural phenomena-flooding, drought, etc., but not at fertilizer or improved seed that is not available when needed.)

Similarly, the United States does not have a dual economy separating rural and urban areas. Because of relatively high purchasing power in U.S. rural areas,

distribution systems are in place and functioning, whereas in developing countries the state often has to assume that role. The problems Third World farmers have in acquiring input resources in a timely fashion eventually forces FSR&D to look at institutions as well as contained production systems.

In developing countries, the maintenance, development, and procurement of farm resources involve, for example, the gathering of manure and the making of tools, as well as the gathering of fuel and water that take up endless hours. Fuel and water are a crucial part of the farming system. They are essential to maintain the family to reproduce the labor necessary to continue the farm work (Hanger and Moris, 1973). This mix of reproductive and productive work, in terms of the maintenance, development, and procurement of farm resources, and the degree to which women perform most of them, is crucial if we are to understand fully the constraints under which marginal producers operate (Abdulla and Zeidenstein, 1981).

The farming system is composed of a variety of subsystems: social, biological, technical, and managerial. All of these must be understood as they interact with each other. Because of the lack of technology, the relation between the parts is often very sensitive. In comparing overseas agriculture to U.S. agriculture, we find that, in the United States, technology has overcome many of the biological differences that cause different constraints to be important. Irrigation, of course, is a major technological innovation that has overcome a large number of constraints in many parts of the world. Irrigation tends to be in the hands of large-scale landowners (Pearse, 1980:107). In work such as that at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the complex social nature of putting into practice irrigation systems that take into account the needs and input of small farmers is being attempted (Matlon, 1980).

FSR and Farm Management Research

When we talk about farming systems research, many people who have long experience in land-grant universities shrug their shoulders and say, "That's new? Isn't that what we've always been doing in farm management research?" Certainly farm management, as it evolved, was a multidisciplinary attempt to look at the entire range of factors involved in running a farm enterprise, Gilbert, Norman, and Winch discuss briefly the relation of farming systems research and farm management research:

> Despite important similarities between FSR and the early forms of farm management research, differences are apparent in the treatment of motivations and the flexibility of recommendations emerging from the analysis of existing farming systems. Farm management research assumed that successful farmers had to be thrifty;" hard-working, profit maximizers. They would prosper, expand, and should be emulated. As late as 1947, farm management was being defined as "the act of judiciously and skillfully managing a farm" (Boss and Pond, 1947). Further, much of farm management literature tended to be prescriptive in nature, indicating what farmers should do to be successful rather than trying to understand the logic of the farming practices that the mass of farmers were using (Gilbert, et al, 1980:121-122).

Thus, where prescription might work in the United States because assumptions about goals could be taken for granted, we cannot easily prescribe in developing countries, particularly among limited resource farmers. We cannot assume that people want to expand, to get larger to maximize profit. Further, we must realize that one farmer expanding pushes another off the land, where even fewer chances of generating income can be found. Families on Third World limited resource farms seek to minimize risk. Often people will want to use any surplus generated for off-farm investments, instead of reinvesting surplus in the farm, which has been the assumption of profit use in the United States. In the Third World, surplus generated is used rationally for ceremonial consumption which serves to further unite the community-to ward off the possibilities of divisions that would weaken everyone as the whole was weakened. Surplus may be invested to send children to school. These children ultimately work off the farm, where chances of higher return to the investment are available. Farming systems research attempts to integrate differing goals into research programs aimed at limited resource farmers.

Current farm management in the United States has as its goal the greatest continuing profit (Buller, 1976:1). This assumption for limited resource farmers in developing countries cannot be taken for granted. Other goals may be motivating the farm family, and these goals must be recognized and taken into account when technology is recommended, research is done, and results are assessed.

In farm management, as currently practiced in the United States, the assumption is that profitability is the goal. Profitability has the advantage of giving us something easy to measure. Weber called it formal rationality necessary for a modern economy (Weber, 1947:184-186). But many Third World marginal farms are not part of the modern economy. Profitability can be measured by reducing inputs and outputs to dollars and cents, which can be easily subtracted from one another. That single summary measure makes for easy comparisons between farms. In developing countries, because we cannot assume that the highest continuous profitability is the goal, we have to devise other measures of success. We can no longer reduce all inputs and outputs neatly and carefully to economic terms.

In the United States, early Farm Management Research (FMR) assumed that a better cropping mix and more judicious use of resources would improve the farm family's welfare-and maintain soil productivity-through higher sustainable incomes. It took a long-term view and included costs that could be externalized, such as land erosion and water quality and sustained quantity. FMR allows for an approximation of experimental conditions by examining existing practices to see what was the most profitable; it then helped farmers to apply the results of this quasi-experimental research through good record-keeping and problem analysis (McDermott, 1982, personal communication).

In Third World FSR, the researcher works with the farm family to decide upon appropriate innovations that can be introduced to increase farm family welfare, yet not contradict long-range societal goals. Generally, this involves increasing profits, but reducing risk is even more crucial for the limited resource Third World farmer. Maintaining a fragile ecosystem, which may be antithetical to farm profitability, must also be taken into account.

In early FMR in the United States, it was demonstrated that the diversified family farm was better able than the mono cultural farm to withstand the inevitable dips and rises in the price structure. Yet, because of the constraints of

introducing more efficient machinery to reduce labor costs and troubles, and because research was commodity oriented and not system oriented, agriculture steadily became more oriented to monoculture- and more susceptible to market trends (Flora and Rodefeld, 1978). For the limited resource Third World family farm, the purchase of large, efficient equipment is impossible, even if the fuel and other inputs would continue to be available to run it. Further, limited resource Third World farmers do not have the ability to withstand several years of bad prices if a single crop is depended on. The family farm diversifies its sources of income, even if such a tactic may be inefficient in receiving the highest return on any single crop. (Research carried on by Instituto Colombiano Agropecuario (ICA) in Rio Negro, Antioquia, shows the superiority of a cropping system using beans, corn, and potatoes over maximizing the yield of any one of the crops.)

Farm management, like FSR, starts with problem identification. Identifying the problem is the only way to go about solving it. However, methods of problem identification learned and shared, for example, by mid-western farmers, extension agents, and researchers, may be very different from both the logic and the perceived problems of farmers in developing countries. Farm management research, as farming systems research, stresses that data are necessary in order to make the proper decisions. Those data involve what people actually do and the implications of these actions related to their perceived goals.

According to current farm management theory, the successful U.S. farmer has specific and definable goals and objectives (Buller, 1976). Part of farm management practice is to help people develop these goals and objectives, which are primarily financial, generally within terms that are numerically operational, often facilitated by computer.

Less successful U.S. farmers do not have goals and are more passive (Buller, 1976). They wait to see what will happen to them. That is a more fatalistic approach, but one which is more congruent to people who may not control directly all the resources necessary to farm. For example, in the developing countries, if you are a tenant farmer it is difficult to set goals because you cannot control what will happen (Griffin, 1976). If, as in many cases, you are a woman farmer-which is increasingly likely as male migration to seek off-farm employment increases-your ability to control labor as well as other resources is greatly diminished vis a vis males (Bourque and Warren, 1981). Setting goals and objectives is outside the farmer's purview when the farm has to respond to resource scarcity. Farming is reactive when access to inputs is limited. When access is even more limited because of gender and differential power, often caused by a colonial history (Etienne and Leacock, 1980), farming becomes

Farm management research in the United States has assumed that the farmer is male, and the successful farmer "involves his wife as a meaningful helpmate in his business and community affairs" (Buller, 1976:4). The assumption behind farm management research is that farming is a family enterprise and is only successful when this occurs. This same assumption is held in FSR. The difference is that we realize that in the Third World the farmer will sometimes be female, and in certain situations (particularly when we are talking about limited resource farmers producing subsistence crops) the farmer is more likely to be female than male. The realization of who does the farming versus who is getting the agricultural information is crucial. This disjuncture must be taken into account as we try to overcome our cultural biases in approaching development processes.

Third World farms are linked to the capitalist market in three ways: the sale of their products, the sale of their labor, and the inputs they purchase. Linkage through the sale of crops is most common in the United States. Yet, the majority of the crops very often are not sold, but are consumed on the farm or bartered locally, particularly in parts of Africa and Latin America.

The more usual way in which the small farm in the Third World is linked to the market economy-that is to say to the world system- is through the sale of labor. The farm family becomes semi-proletarianized, with one part of the family maintaining the farm and production, and another part of the family selling their labor in the market (Goodman and Redcliff, 1982). The people who sell their labor tend to be those who command the highest wages because cash takes priority. These people tend to be males (Leon, 1982). This leaves women in charge of production of subsistence crops-the wage foods-that are the backbone of the economy. Yet these crops are the least valued within that society. Men will take jobs, generally through temporary migration (Friedman, 1978; Laite, 1977) and will work in the harvest of cash crops, particularly export crops (Homen de Melo and Zockun, 1977). Export crops include cotton, coffee, cacao, and sugar. The men also may be involved in the construction booms that accompany petroleum development. For instance, in Ecuador and in Nigeria, men will migrate to the urban centers to provide a low-wage construction labor force. Employment in extractive industries, particularly mining, can also be the first major link with the monetary economy. In much of southern Africa, the movement of males to work in the mines has left farms in the hands of females.

It is important to understand that in both farm management and farming systems research the increased commercialization and increased penetration of capitalism has made a sharp impact on the farm family, but the way that has occurred is very different in the Third World when compared to the developed world. Perhaps a good way of seeing this is through understanding where in the United States farm management as a science first evolved.

In the United States, farm management research was first developed in the Northeast and the Midwest (Case and Williams, 1957), where independent farm families controlled the land and provided the vast majority of their own labor. It developed much more slowly in the south, where agriculture was dominated by the sharecropper-tenancy type of organization that tied the farm family on the land closely to the landowner for direction and financing. That separation of the factors of production in the farming system reduces efficiency. Access to and was divided from ownership. Management was split. Labor was separated from the land and, as a result, production credit was difficult to obtain. When the goal of profit maximization was addressed in the South, one had to ask, "Profit maximization for whom?"

This is certainly the case in much of Latin America today. The conditions for effective farm management research do not exist as we know them. However, farming systems research, using many of the early principles of farm management research (particularly those that closely linked agronomy with the diverse goals of the farm family), can be useful. But, in order to be most effective, we have to set aside our assumptions about the conditions under which research and extension take place.

First, the limited resource farmer, particularly women farmers, will not have the political organization and clout to influence the programs presumably

designed to help them. Second, agricultural researchers and extension workers will not have the same social, cultural, and economic backgrounds as the limited resource farmers. In particular, they will not have the same gender-related experiences. They will not know what it is to carry water, gather wood, cook meals, and nurse babies while also planting, harvesting, and processing crops. That lack of understanding may provide a large constraint to the development of appropriate technology and the adoption of innovation to increase productivity by female farmers. Third, manual work, particularly women's work, will be devalued by those who work with their "heads." Respect and appreciation of the manual aspects of productive and reproductive work have to be developed. Fourth, temporary male migration in order to increase family cash income will leave women in charge of farming. No longer can we assume, "the farmer, he..." Fifth, men usually have more control than women over the factors of production- the inputs to the farming system (land, labor, capital, technology, and management) both on and off farm. We must understand these separations and devise mechanisms to overcome the constraints they entail. Sixth, because of farmer's economic marginality, the integrative function between research and application performed by private enterprise in more lucrative settings will have to be assumed by other mechanisms, probably with strong public sector participation. Seventh, we must deal with marginal farmers, who are more likely than large-scale farmers to be women, rather than simply deal with the modern or potentially modern sector, which is male-dominated. Much of domestic food production, as contrasted with export crop production, is done by Third World women.

We must recognize and deal with the differential structural conditions of research-extension-production and the unique roles of women within it, if we are to gain the objective of increasing the agricultural welfare of Third World farm families-and improve agricultural productivity and the general welfare throughout the world.

## REFERENCES


Abdullan T. and S. Zeidenstein. 1981. Village Women of Bangladesh: Prospects for Change. Pergamon Press, Oxford, England.

Anderson, J.R., K. Dvorak, S. Setboonsarng, J.A. Roumassett, and M.H. Vesenka. 1982. BNF and the U.S. rice industry: A review of economic aspects toward a technological assessment of BNF. Interim Report, Resource Systems Institute. East-West Center, Honolulu, Hawaii (Sept. 22, 1982).

Bagley, B.M. and F. Botero. 1978. Organizaciones campesinas contemporaneas en Colombia: Un estudio de la Associación Nacional de Usuarios Campesinos (ANUC). Estudios Rurales Latinoamericanos. 1 (Enero-Abril):59-6.

Barraclough, S.L. 1973. Agrarian Structure in Latin America. D.C. Health, Massachusetts.

Barsky, O. and G. Cosse. 1981. Tecnología y Cambio Social: Las Haciendas Lecheras del Ecuador. FLACSO, Quito, Ecuador.

Bernstein, H. 1977. Notes on capital and peasantry. Review of African Political Economy. 10:60-73.

Bourque, S.C. and D.B. Warren. 1981. Women of the Andes: Patriarchy and Social Change in Two Peruvian Towns. The University of Michigan Press, Ann Arbor, Michigan.

Buller, O. 1976. Farm Management Laboratory Manual and Supplemental Text. Dept. of Economics, Kansas State University, Manhattan, Kansas.

Busch, L., W.B. Lacy, and C. Sachs. 1980. Research policy and process in the agricultural sciences: Some results from a national study. RS-66. Dept. of Sociology, Kentucky Agricultural Experiment Station, Lexington, Kentucky.

Case, H.C.M. and D.B.Williams. 1957. Fifty Years of Farm Management. University of Illinois Press, Urbana, Illinois.

CIMMYT (Centro Internacional de Maiz y Trigo). 1981. CIMMYT Economics. CIMMYT, Mexico (April).

Clarke, J. 1980. Peasantization and landholdering: A Nigerian case study, M.A. Klein, ed. Peasants in Africa: Historical and Contemporary Perspective. Sage Publications, Beverly Hills, California.

Deere, CD. and M. Leon de Leal. 1980. Women in Agriculture: Peasant Production and Proletarianization in Three Andean Regions. Unpublished manuscript, International Labor Organization.

Etienne, M. and E. Leacock. 1980. Women and Colonization: Anthropological Perspectives. Praeger, Brooklyn, New York.

Flora, J.L. and R.D. Rodefeld. 1978. The nature, magnitude and consequences of changes in agricultural technology. In Change in Rural America: Causes, Consequences and Alternatives. Rodefeld, Flora, D. Voth, I. Fujimoto, and J. Converse, eds. C.V. Mosby Co., St. Louis.

Friedmann, H. 1978. World market, state and family farm: Social basis of household production in the era of wage labour. Comparative Studies in Society and History. 20(4):545-586.

Gilbert, E.H., D.W. Norman, and F.E. Winch, 1980. Farming systems research: A critical appraisal. MSU Rural Development Paper No. 6. Michigan State University, East Lansing, Michigan.

Goodman, D. and M. Redcliff. 1982. From Peasant to Proletarian: Capitalist Development and Agrarian Transitions. St. Martin's Press, New York.

Griffin, K. 1976. Land Distribution and Rural Poverty. MacMillan Publishing Co., London.

Grossman, R.S. 1982. Control of agricultural germplasm and genetic information. Paper presented at the Conference on Biotechnology, Agriculture, and the Public Interest, University of Kentucky, Lexington.

Hanger, J. and J. Moris. 1973. Women and the household economy. Mwea: An Irrigated Rice Settlement in Kenya. Weltforum Verlag, Munich.

Homen de Melo, F.B. and M.H.G.P. Zockun. 1977. Exportacoes agricolas, balanco de pagamentos e abastementos do mercado interno. Estudos Economicos. VII(2).

Kelly, K.D. 1979. The independent mode of production. The Review of Radical Political Economics. 11:38-48.

Laite, J. 1977. Migration, capital accumulation and social differentiation amongst the peasantry. Paper presented to the Social Science Research Council, Anthropology Workshop, University of Sussex.

Leon, M., ed. 1982. Las Trabajadores del Agro. Vol. II. Debate Sobre la Mujer en America Latina y el Caribe-Discusión Acerca de la Unidad Producción-Reproducción. ACEP, Bogota, Colombia.

Matlon, P.J. 1980. Local Varieties, Planting Strategies and Early Season Farming Activities in Two Villages of Central Upper Volta. ICRISAT, W.A. Economics Program, Progress Report 2, Ouagadougou, Upper Volta.

Pearse, A. 1980. Seed of Plenty, Seeds of Want: Social and Economic Implications of the Green Revolution. Clarendon Press, Oxford.

Rothstein, M. 1978. Crisis and change in a century of American agricultural research. In Outreach Programs of the Land Grant Universities: Which Publics Should They Serve? J.L. Flora and J. Converse, eds. Kansas State University, Manhattan, Kansas.

Shaner, W.W., P.F. Philipp, and W.R. Schmehl. 1982. Farming Systems Research and Development: Guidelines for Developing Countries. Westview Press, Boulder, Colorado.

Weber, M. 1947. The Theory of Social and Economic Organization. The Free Press, New York.

World Bank. 1981. World Development Report. Oxford University Press, New York.

# KEYNOTE ADDRESS: AN OVERVIEW OF FARMING SYSTEMS RESEARCH

Hubert G. Zandstra[1]

## Introduction

Farming Systems Research (FSR) represents a new approach to agricultural research. It was formulated in response to the complex production methods encountered on small, often mixed farms in the developing world. Its history during the 1970's is a fascinating area for study, and shows antecedents of FSR in rural development, farm management economics and on-farm testing of agronomic practices. These divergent sources probably explain why so many different activities can bear the same FSR label.

The confusion about FSR's identify has led to disappointments among research administrators and funding agencies who, generally unfamiliar with FSR to start with, often obtained something they had not bargained for. The range of objectives and research methods that are conveniently subsumed under the FSR label also meant that recent students and trainees in the subject had to deal with contradictions and incomplete arguments. While this may not be a bad selection procedure for FSR practitioners, it is hardly an endearing way to deal with newcomers.

As an introduction to this symposium, I will review the more common objectives, research approaches, technology evaluation techniques and institutional formats encountered in FSR and describe their relationship to agricultural research and development activities.

This overview will also serve as a commentary on trends in methodological developments and problems encountered in field applications of FSR.

## Historical Context and General Objectives

Earlier FSR-like activities, as reviewed by Gilbert et al (1980) and Whyte (1981), were motivated by a desire to develop improved production methods for small farms in developing countries. Part of the early researchers decided to study the existing system, part opted for experimentation with new techniques. Those who described existing systems tended to be social scientists concerned with the behavior of the systems and with changing the priorities of agricultural research centres. The experimenters were typically agronomists, bent on conducting trials of new production techniques in an appropriate environment.

In the mid-seventies, researchers increasingly combined descriptive activities with experimentation (Garrity et al, 1981) or used experimentation as part of descriptive work (Norman, 1974). An increased realization of the social, economic and institutional constraints under which farmers operate

[1]Associate Director, International Development Research Centre, 5990 Iona Drive, Vanouver, B.C. Canda V6T 1L4. The opinions expressed are those of the author and do not necessarily represent those of the Centre.

and the complex goal structure of the family farm led to a search for new performance criteria for agricultural technology; criteria that would reflect the demands placed on new technology by farmers' goals structure and their production constraints (Zandstra et al, 1981).

Institutionally, research station bound biologists were encouraged to venture into the farm community and to consider economic returns and limitations to production inputs in their formulation of production recommendations. The emphasis on problem specification or "upstream" FSR, probably received its greatest impetus from International Research Centres, most of which, until recently, did not consider the support of location-specific technology development to be within their mandate. The ever-suspect social scientists in these centres, therefore, had to find an acceptable justification that would allow them to conduct on-farm research and provide them with information about existing production systems and the performance of the Centre's technologies. This information had to be convincing enough to change the ways of plant scientists and to change the Centre's reluctance to support "downstream" FSR.

The controversy about FSR activities of International Centres (CGIAR, 1978) and the difficulties encountered by funding agencies and U.S. universities in understanding FSR shifted the attention away from some of the original objectives of early workers in FSR-like research:

- To make available to small farm communities an effective agricultural research system

- To expose weaknesses in the institutional support to agricultural production from small farms

- To familiarize young researchers with the problems of small farm communities

Increasingly, on-farm research was conducted for methodological reasons, or to solve general commodity or disciplinary controversies. Also, the research direction and execution has become dominated by Ph.D. level scientists and foreigners.

On-farm FSR also became confused with assorted research activities that use a farming systems approach to the solution of perceived production problems such as phosphorous deficiencies, nitrogen-efficiency or varietal performance. The FSR approach is also widely applied to identify selection criteria for breeders and management bottlenecks for agronomists, to test in the farm setting an imported production solution (ULV sprayers), or to develop a better survey or record-keeping technique. Although a systems research approach to the solution of these problems is undoubtedly laudable, these activities do not satisfy the original FSR objectives.

I suggest that the term FSR be limited to a research activity that has the following characteristics:

- Its objectives should be to generate improved technology that is acceptable to farmers of a defined region, farm type or well circumscribed production environment.

- The technology search should not be confined to a pre-conceived input (e.g. irrigation), or crop animal enterprise. It should consider land use as a variable.

- The technology should remain within recognized limits on the availability and productivity of purchased inputs and resources of the farm and the community.

- The technology should be evaluated in its effect on all production subsystems of the farm.

For those not familiar with FSR, Appendix I provides a summary of an FSR methodology widely used in Asia and Central America.

Research Methods

A wide range of methods is used to arrive at production recommendations for small farms. Recommendations are still on occasion formulated strictly from results of research station experiments. A better single-step approach is the direct formulation of a recommendation from an on-farm diagnostic study. This is similar to the farm management approach to extension used in the United States. Without institutional intervention this will, however, rarely lead to farmers' adoption of recommended practices in small farm communities of developing countries. The approach also fails to exploit opportunities offered by new technologies.

Recommendations are at times based on the results of widespread on-farm testing by researchers of fertilizer or other inputs. These tests are designed and executed by researchers who often ignore the farmers' method of land preparation, planting and intercropping. Beyond information on biological responses, such research contributes little to improve productivity of small farms.

At times, a farm diagnostic is used to complement on-station research conducted to arrive at a recommendation. In the best cases, this research carefully copies management procedures, input use (where not experimentally varied) and implements from the target farm group. This "module" approach is particularly common where substantial land modifications (ponds, channels, corrals) or large animals are involved in the research and where modifications are complex and have effects on the whole farm. Where farmers are involved to provide feedback on the module (Riesco, 1982), or to manage it (Nitis, 1982), and when the design of the alternative system and its performance criteria reflect constraints of the farm community, the module approach combined with a farm diagnostic and farm monitoring can be an effective research tool.

A more desirable approach is to combine on-farm testing with research station work in a complete program of testing activities that provides information on the performance of component technology (planting date, varieties, insect control, feeding methods, etc.), that compares alternative subsystems to the existing one(s) and that involves farmers in the execution of trials (Work group 3 report, in Fitzhugh et al, 1982). For crop-animal production systems, this testing will undoubtedly have to include comparison among sample farms with and without the alternative production method (De Garcia et al, 1982). This research, as well as the approach that employs modules, should arrive at a specification of the recommendation to be extended to farmers, the adaptation domain for the recommendation, and the institutional intervention (input and credit availability, price or market support, etc.) required for adoption.

To summarize, FSR methods must include a farm diagnostic; a valid comparison of experimental systems, subsystems or components to existing ones, a meaningful

participation of farmers in the execution and design of experiments and surveys; and the specification of the adaptation domain and the institutional demands of any recommended practice.

Performance Criteria

Although there is still a wide range in approaches, at this day and age few agricultural researchers will formulate recommendations based on maximum yield or biological efficiency. Most will compare the alternatives they test by some economic performance measure-generally returns over variable costs (RAVC). Unfortunately, many tests omit comparison with the farmers' practice, and where the "farmers level" is included it is often poorly simulated.

In order of increasing preference, the performance measures often used to compare an experimental management component or sub-subsystem (feeding system) or subsystem (goat production system) to that used by the farmer are:[1]

1. RAVC of the system component under study.

2. RAVC and marginal benefit cost ratio (MBCR) of the introduced component (e.g. maize + beans - sorghum, goats) and enterprise under study over the existing one.

3. As for 2, adding checks for conflicts in resources (labour) available to the whole farm.

4. As for 3, adding checks for conflicts with other enterprises, off-farm employment, or social obligations - and adding risk considerations.

5. Whole farm analyses using simulation or linear programming methods, including risk considerations.

Experience with B.Sc. level research teams has been that the second alternative when augmented with detailed questioning of farmer cooperators about risks, resource conflicts and the effects on the remainder of the farm enterprise, is a manageable and effective approach. Although a sensitivity for high risk and high input alternatives should be developed, complex numerical treatment of risk is not for field teams. The same applies to quantitative whole farm analyses.

Institutional Formats

In the loose sense of the term, FSR has been conducted by isolated voluntary groups, universities, temporarily funded regional development projects, and extension, research and planning divisions of ministries of agriculture. Although university involvement is important because of the educational implications, it achieves little towards providing the small farm communities with stable access to the country's research capability.

To achieve developmental objectives in small farm communities, FSR activities should be included as an on-going part of the national agricultural

---

[1]See for examples: Norman (1977), Jayasuriya and Price (1980), Banta (1980).

research program. The framework for FSR and the methodological expression given to it must therefore project forward to an institutional model that is within reach of developing country governments (Zandstra, 1980). This implies a judicious allocation of research and training responsibilities to staff working in the farm community, in regional and central research stations and at universities.

The experiences gained in cropping systems in research in Asia were strongly based on an institution-al model (Table 1). This model considers a national research program in which area-specific systems research is conducted by interdisciplinary teams of three to four professionals with locally hired technicians and village assistants. These teams are supported by a technical committee of experienced farming system researchers that can provide support in the design of technology and in the design and execution of research on the site. Through decentralization of research decision-making, the site teams must become increasingly instrumental in the formulation of their research. They must always be responsible for the initial analyses (be it graphic) of their results and for the presentation of these results to their peers and superiors. The site research teams are completely dependent on provincial and nation-al research centres for their awareness of new component technology. They should have access to a range of varieties of the crops with which they work and to the agricultural chemicals or supplements they may need to employ. They should be kept aware of ongoing research in the commodities they deal with through visits and publications. There is a great deal of truth in the observation that the success of FSR depends as much on the range of component technology available at the research site as on the methodological capabilities of the research team. Too often, a lack of viable improved seed for forage crops and grain limits the effectiveness of on-farm research.

The structure and leadership provided to interdisciplinary teams at the on-farm research sites or at the national or international research level are key elements in farming systems research (Flinn and Denning, 1982). The most successful research teams have a sharp focus, are small (not more than seven persons), and are encouraged by the team leader to arrive at a consensus through mutual discussion among team members. It is therefore important to limit the scope of the teams' research activities to those farm enterprises on which they can have substantial impact and for which they have access to component technology.

The scope of FSR activities is an important consideration. To conduct research on several crops requires access to a range of varieties, knowledge of different planting methods or intercrop combinations, a strong diagnostic capability for damage due to diseases, insects and nutrition related problems, and familiarity with experimental and measurement techniques that are specific to certain crops. Adding to this a similar capability in animal enterprises can quickly overload the team's capability and will require technical support from a different department in the Ministry. For these reasons, a careful choice of research emphasis must be made for an FSR team in a certain target area. In this choice, access to expertise and existing component technology and the expected impact on the farming system are of course important considerations.

## International Support to FSR in Developing Countries

The principle objective of international support to FSR is to help national research programs respond to the needs of small farm communities. It is to install a national capability through training and practice. Support to such an endeavour should be in the form of collaboration, not of leadership.

The whole purpose of international support to national FSR activities is to develop the national capability and research structure for the effective functioning of on-farm research teams and the required technical support and coordination at the provincial and national level. This purpose is best served by assuring that expatriates do not conduct the research and that leadership and decision-making about the role of FSR and its institutional place remains in the hands of the recipient.

Expatriate FSR advisors can stimulate the formation of, initially, a few on-farm research teams. They can back those up through training, advice, analytical and operational support and encouragement. The research should, however, remain the responsibility of each team. At the regional or national level, the advisors can encourage the coordination of operational and technical support to FSR teams. They can influence support research by scientists based at research stations and in universities, involve students in the research and encourage the formal feedback from FSR teams to commodity programs through meetings and workshops. The use of large multidisciplinary teams of expatriates in FSR&D projects is counter productive. It overloads the host institution, which is kept busy to contain the foreigners; it shifts the responsibility for FSR implementation from the recipient to the expatriate institution; it emphasizes a centralized highly capable group, whereas major emphasis should be on B. Sc-level field teams; and it reduces the probability of selecting excellent, patient, development oriented advisors.

The presence of one, at the most two, expatriates, should be sufficient. These should be young enough to be approachable and to learn with national colleagues, yet old enough to have had in-depth experience in agricultural research in a small-farm community. They should be thoroughly familiar with FSR concepts and should be asked to work for an extended period with national scientists and in the national research organization towards an institutional model for the application of downstream FSR.

Any support to commodity and disciplinary research in the same institution, while recognizing the required linkages with the FSR activities, should not be labeled FSR.

## CHANGES IN ON-FARM PRODUCTION SYSTEMS RESEARCH METHODS:

### Description or Diagnostic Phase

During the last five years, continuous change took place in the methods for the description of the existing production systems in selected target areas. Initially, elaborate farm surveys were the norm. These were generally static (once over) in nature and dependent considerably on farmers' recall of events in the production cycle, Many researchers found this approach cumbersome and felt that limited insight was obtained about biological or socioeconomic production constraints. Increasingly, initial surveys have changed towards more interactive studies that focused in on perceived constraints (Collinson, 1979; Hildebrand, 1981; Van Der Veen, 1980). These surveys began to employ inter-disciplinary research teams (less input from interviewers). They continuously incorporated their findings into a generally agreed upon format and adjusted their questioning of farmers, community leaders, and key informants towards aspects that required further elaboration. This approach has allowed a much quicker start of experimental work on key components.

The reduced duration and cost of the diagnostic study was also encouraged by an increasing awareness among applied research teams that the descriptive component of FSR continues during the experimental research phase. Record-keeping generally on a small number of case farms or selected sub-enterprise (e.g., fields, swine enterprise) continuously refines the teams' understanding of the performance of the existing system. A major advantage of this approach is that the performance of the existing system becomes understood in comparison with a number of alternatives.

The diagnostic phase of FSR has also improved in efficiency because FSR researchers gained experience in identifying which variables were critical and which variables could be measured at a later stage. In this respect, further work is needed towards simple graphic representations of the mixed farm and the contributions of the sub-enterprises to each other, to the farm family, and to the market and vice versa. Presentations such as those used by McDowell and Hildebrand (1980) and those developed by Hart (e.g. Hart et al, 1982) provide an excellent insight into the interactions and limits that operate on the farm.

These presentations of existing farming systems should give more attention to the multiple objectives of the animal enterprise. For the crop enterprise, the importance of shade, litter information, dry season feeding of by-products or clippings and wet season use of thinnings and weeds for feed are still often ignored. For the animal enterprise, the relative importance of its multiple products for consumption or sale (milk, meat, hides, fiber, heat, fuel, cooking fat), or for the function of the farm (e.g., traction, security through savings, on-farm and off-farm scavenging, recycling of nutrients, control of pests, capturing marginal labour) should be determined.

Design of Alternative Systems

The design phase involves the formulation and ex ante evaluation of one or a number of alternative management components or subsystems. It also involves the design of research techniques that allow the evaluation of the performance of these alternatives in a background set of management methods that is as close as possible to that used by target farmers and that allows their comparison to the farmer's methods.

Many FSR research programs have been overly hesitant to encourage field teams to include substantial changes in farming practices. This hesitation comes from numerous experiences of farmers' rejection of new technology. In part, this careful approach to the formulation is also a result of our avowed objective to generate technology that is acceptable to farmers. This had led to notions of incremental change and low input systems becoming predominant in FSR circles.

One of the most common constraints of small farm production systems is precisely farm size and the farmers' limited access to inputs that would increase production. These communities often have excess labour, or available labour can be created by increasing the labour efficiency of selected operations. Such labour can be invested in farm improvements such as field leveling or drainage, building of storage structures, or in secondary production processes often involving animal products. It can certainly be used to support additional labour demands that arise from a greater production of food or fodder crops obtained from changes in crop varieties and input levels.

It may be instructive for research teams to approach technology design with a knowledge of biological potentials and an understanding of the yield gaps that

operate to reduce production to the level observed on farms. By estimating the value of yield and production losses, researchers can then identify which constraints, when removed, will be most efficient in improving production per unit cost. They can also estimate how much the additional inputs that are required for the removal of the production constraints are allowed to cost. (Less than one half the value of the yield gap is a good starting point.)

Analyses of the reasons for the rejection of new technology by farmers reveals that they are generally because:

- claims made about the benefits of technology are not realistic, because yields are lower, costs are higher or product prices and acceptability are lower than those assumed by the researchers.

- infra-structural support is lacking because of lack of political will, poor management by the institutions involved, or weak design of institutional support programs (credit, input availability, marketing).

Extensive on-farm testing, careful economic analyses and serious consideration of farmers opinions helps FSR teams avoid the first set of reasons. Research teams should be continuously reminded to be critical of the technology they test and to take farmers' comments seriously. The failure of the delivery system, or of production programs, has become a major concern of FSR teams (Zandstra, 1980). The major reasons for this failure have been that researchers were not realistic in their assessment of the type of infra-structural support that will be available, and that extension staff had not participated in the selection of the target population and in the final evaluation of the new techniques to be recommended. It is therefore important for researchers to discuss with extension groups the type of technology they are considering and to consult them about the credit and input support this technology may require. FSR researchers should also participate in the design of production programs to ensure that the institutional pre-requisites of the new recommendations are met.

Other aspects of the design of technology that merit discussion are:

- The design process is a critical step in the functioning of cross disciplinary research. Care must be taken to avoid disciplinary bias and the team's energy should be channeled towards the synthesis of feasible, and promising alternative production methods.

- Procedures for ex ante analyses of the relative merit of alternative technologies should be strengthened (Flinn and Denning, 1982). Anderson and Hardaker (1979) conclude that skilled intuition, complemented with the careful application of simple budgeting-based models, remain the most useful techniques. Skilled intuition is, however, hard to teach. The ex ante evaluation of designed technology that influences both the crop and animal production enterprise becomes very complex. The animal production sub-system can interact in many ways with the crop sub-system and testing of substantial changes in animal production is difficult on small farms. For this reason, at a recent meeting, animal production systems researchers emphasize the need for simple whole-farm models (Li Pun and Zandstra, 1982). These models would be used to estimate the performance of designed component technology before on-farm testing. They would also be used to compare the performance of alternative sub-systems which incorporate several technological innovations.

- More importance should be given to the objectives the farmer has for his production activities. The fact that he has a few pigs scavenging around the house does not mean that he necessarily should become a commercial swine producer, who would depend on the availability of commercial concentrates and the presence of a veterinarian. Such a change may destroy the original objective of his keeping a few pigs as a low risk, low input activity on which he can fall back in times of need. This does not mean his pig production methods cannot be improved. Improvements must, however, fit the objectives the farmer has with this enterprise. For research purposes, these objectives have to be expressed in terms of imitations on cash and labour inputs (including by whom) and productivity and risk criteria.

Testing Phase

Results of farming systems research have shown the importance of a critical comparison between the alternative introduced by researchers and the system used by the farmer. This comparison should be based on as similar a data collection scheme as is possible for both sets. The use of paired comparisons of both systems within land type, farm type, village and if possible, farm family is advisable.

Testing should actively involve farmers and, where community decisions are affected, the farm community. This applies to the evaluation of simple technological components as well as to the testing of complete sub-systems. In this respect it is useful to recognize a range of farmers' participation:

a) as observer, when the researcher designs and executes a trial on the farmer's land, often through a rental agreement

b) as executor of a test designed by the researcher but realized by the farmer, who conducts all operations. The farmer uses his resources, often augmented by production inputs or implements and supervision from the researcher

c) as participant in design of the trial and its execution as under

b) as originator of the test, through partial or complete adoption of a recommendation, using his own means to obtain additional inputs that may be required, from a production infra-structure specifically designed for the introduction of the new technology (pilot production program).

e) as originator of the test without access to special institutional arrangements.

It should be emphasized that only the test situations in d) and e) can provide realistic estimates of the performance of the new technology. In the case of complex alternative production systems involving substantial land modifications or large ruminants, it has been suggested that researchers should resort to cooperatively managed farmer-executed trials of the whole system. For these trials, the inputs not available to the farmer will be provided through a pilot production program that assures availability of credit and inputs that insures farmers a return at least equal to that obtained from his actual production system. Examples of such underwritten tests of new technology are the maize and onion production programs described by Zandstra et al (1979) and the Zamboanga del Sur Development Project (Denning, 1981).

There is a continued need to improve measurement and analytical techniques for performance criteria that can be used with confidence to separate attractive and non-attractive technologies. These criteria have to be in relation to existing or designed socio-economic and institutional (tenure, cooperatives, credit, inputs, market, prices) structures. It may not be an exaggeration to blame the absence of this analytical ability for the fear among researchers of substantial changes in production systems, even though there are radical changes initiated or adopted by farmers.

## Conclusions

The major thrust of FSR activities should be to make an effective research system available to small farm communities that lack economic and political power. This objective has research methodological and institutional implications that should be taken into account in international programs sup-porting FSR research.

The term FSR should be more selectively used to refer to the inter-disciplinary research activity that considers all enterprises of the farm, the farm's resource base and its environment in the identification of improved production systems that are acceptable to a defined population of farmers.

Groups involved in farming systems - cropping systems - or animal production systems research should not feel obliged to seek simultaneous technical change in all farm enterprises. It is more important for them to focus on the enterprise(s) to which they can bring to bear the required expertise and component technology and to make sure that biological and resource use interactions with other enterprises are given due consideration.

Although research teams must continue to be critical about increasing purchased inputs, the use of additional inputs and equipment to increase productivity should not be ignored. More work is needed to insure that realistic assumptions about the availability of credit and inputs are made in consultation with extension services and the institutions responsible for input and credit delivery to the farm community.

On-farm testing of crop and particularly animal production technology requires careful structuring and normally is associated with difficulties. With patience, sensitivity to farmers limitations and considerable dialogue with farmers, many of the technological innovations can be tested as individual components under farmers' management. Continuous efforts should be made to arrive at more efficient test arrangements with the farm community that protects individual farmers, allows monitoring of inputs and results, and allows researchers to differentiate with confidence between existing and introduced production methods.

Much farming systems research has been conducted by international centres and highly qualified advisors to national programs. Such activities were necessary to develop the needed research techniques and to train future members of research teams. More emphasis should, however, be given to the training of national program research teams and the development of an on-site research structure that is cheap, is technically and operationally well supported, has access to new technology and research methods, and has good links to commodity programs and extension services.

Scientists involved in the development of FSR methods must therefore give serious consideration to the technical level of personnel that will be asked to do on-farm research in national programs. Research methods for on-site research teams must be simple enough for good B.S.c. level professionals, and analytical techniques should be such that they can be managed with hand-held calculators.

## REFERENCES


Anderson, J.R. and B.J. Hardaker, 1979. Economic analyses in design of new technologies for small farmers. In: A. Valder et al (ed). Economics and the design of small farmer technology. Iowa State University Press.

Banta, G.R., 1980. Economic analyses of cropping systems. In: Proceedings of the 1979 workshop on the economics of cropping systems. IRRI, Los Baños, Philippines.

Collinson, M.P., 1979. Understanding small farmers. Paper given at conference on rapid rural appraisal. 4-7 Dec. 1979. IDS. University of Sussex, Brighton, U.K.

De Gracia, M., M. Sarmiento, S. Rios and C. Ortega, 1982. Proyecto de investigacion de alternativas de producción en explotaciones ganaderas de doble propósito en fincas de pequeños y medianos productores. In: IDRC Manuscript Reports: MR 62s, op cit.

Denning, G.L., 1981. An Australian-assisted credit scheme for upland smallholder crop production in the Southern Philippines. Mimeo. IRRI, Los Baños, Philippines.

Flinn, J.C. and G.L. Denning, 1982. Interdisciplinary challenges and opportunities in international agricultural research. Ag. Economics Dept. paper 82-02. IRRI, Los Baños, Philippines.

Garrity, D.P., R.R. Harwood, H.G. Zandstra and EC. Price, 1981. Determining superior cropping patterns for small farms in a dryland rice environment: test of a methodology. Agricultural Systems, 6:269-283.

Gilbert, E.H., D.W. Norman and F.E. Winch, 1980. Farming systems research: A critical appraisal. MSU Rural Development Paper No. 6. Michigan State University, East Lansing, Michigan.

Hart, R., H. Fitzhugh and N. Gutierrez, 1982. Crop-animal production systems research at Winrock International. In: Proceedings of a workshop, research on crop-animal systems. Winrock International, Morrilton, AK, USA.

Hildebrand, P.E., 1981. Combining disciplines in rapid appraisal: the sondeo approach. Agricultural Administration 8:425-432.

Jayasuriya, S. and E.C. Price, 1980. Whole farm analyses and shadow pricing of resources in partial budgets. In: Proceedings of the 1979 workshop on the economics of cropping systems. IRRI, Los Baños, Philippines.

Li Pun, H.H. and H.G. Zandstra, Editors, 1982. Informe del II taller de trabajo sobre sistemas de producción animal tropical. Pucallpa, Peru, 21-25 Jan. 1982. IDRC Manuscript reports: MR 62s.

McDowell, R.E. and P.E. Hildebrand, 1980. Integrated crop and animal production. Making the most of resources available to small farms in developing countries. The Rockefeller Foundation working papers. Jan. 1980.

Nitis, I.M., 1982. Most promising research results for the use of by-products in feeding Bali cattle. In: Feasibility of by-product utilization for animal production. IDRC, Ottawa, Canada.

Norman, D.W., 1974. The rationalization of a crop mixture strategy adopted by farmers under indigenous conditions: The example of northern Nigeria. Journal of Development Studies 11:3-21.

Norman, D.W. and R.W. Palmer-Jones, 1977. Economic methodology for assessing cropping systems. In: Cropping systems research and development for the Asian rice farmer. IRRI. Los Baños, Philippines. Institute international de recherches sur le riz.

Riesco, A., G. Meini and S. Gonzalez, 1982. Proyecto de investigación en sistemas de producción ganadera en la Amazonia. In: IDRC Manuscript Reports: MR 62s, op. cit.

Van Der Veen, M., 1980. Parcel, farm and community level variables influencing cropping intensity in Pundi Bhundi, Nepal. In: Cropping Systems Conference, March 3-7, 1980. IRRI, Los Baños, Philippines.

Whyte, W.F., 1981. Participatory approaches to agricultural research and development. A state of the art paper. Rural Development Committee, Cornell University, Ithaca, NY.

Zandstra, H.G., Swanberg, K., and CA. Zulberti, 1976. Removing constraints to small farm production. The Caqueza project. IDRC-058e. Ottawa. Centre de Recherches pour le Developpement International.

Zandstra, H., K. Swanberg, C. Zulberti, and B. Nestel, 1979. Caqueza: Living rural development. IDRC-107e. Ottawa. Centre de Recherché pour le Developpement International.

Zandstra, H.G., 1980. Institutional requirements for cropping systems research. Cropping systems conference, March 3-7, 1980. IRRI, Los Banós, Philippines.

Zandstra, H.G., E.C. Price, J.A. Litsinger, and R.A. Morris, 1981. A methodolology for on-farm cropping systems research. IRRI, Los Banós, Philippines.

Table 1. Division of responsibilities among components of a national cropping systems program.

| Program Component | Responsibility |
|---|---|
| Network of text sites | Site description, design of improved patterns, testing, Formulation of recommendations with support from Technical Support Team(s) (TST). |
| Regional research stations (Commodity and disciplinary programs) | Component technology research; Varietal screening, long term cropping pattern trials' Performance of agricultural chemicals; Operational support to nearby sites. |
| Technical Support Teams (TST) | Full time team. Visit test sites to provide support in research design, experiential design, analyses and interpretation, ensure feedback on technical and operational problems to the Cropping Systems Program Committee (CIP). Identify trainees, serve as trainer, organize workshops, and combine site results. |
| Coordinated inter-agency Cropping System Program Committee (CIP) | Sets policy, selects sites, structures staff compliments at sites and in technical support teams, monitors methodology used, insures feedback to commodity and disciplinary programs or departments, identifies training needs. |
| Commodity and disciplinary programs or departments | Conduct research on aspects of component technology, environmental classification, research methods and problems identified in on-farm test sites. |

From Zandstra, 1980

# APPENDIX I

## FARMING SYSTEMS RESEARCH FOR IMPROVED SMALL FARM PRODUCTION SYSTEMS

The following is essentially the production systems research framework used by the International Rice Research Institute (IRR) and the Tropical Agricultural Research and Training Centre (CATIE). It consists of seven research phases, which form a conceptual sequence. In practice, however, several research phases may take place at the same time.

1. Selection of the target areas. One or more geographical areas representative of a large homogenous production zone are selected. The area should be a priority area for development by the national government. In this way, when the potential for increased production has been demonstrated, support for production programs will be given.

2. Site description. The first activity of the research is to describe the existing farming systems, the physical environment, the socioeconomic environment and constraints to production. The characteristics of the farm environment will decide research priorities at the on-farm research site and at supporting research stations. At this time, the area is also divided in different land types, each of which may require different production recommendation.

3. Selection of land types or farming systems. The stratification of the target area into land types is based on important environmental traits that are generally reflected in the type of food or forage crops grown and the type of animal feeding system or animal species that predominate. Land types are usually differentiated on the basis of pedological, irrigation, market, climatological or social factors. They should be general enough in occurrence to warrant research expenditures. Because of the staff and funding limitations and to reduce complexity, the research is generally confined to one or two land types and the predominant farm types associated with them. For the selected land types, the predominant farm types are studied in depth over time. This occurs while other research is ongoing and continues through the testing phase. This analysis concentrates on the biological and economic performance of the existing systems and its components. In mixing farming systems, particular attention has to be paid to the competition for farm resources - cash, labour, land, at certain times of the year -, and to input transfers between subsystems-crops as feed, manure as fertilizer, animal power, etc. The particular roles that livestock play in the farm enterprise have to be clearly defined.

4. Design of alternative systems. This includes the design of alternative cropping patterns, feeding systems, animal housing and management methods that are well adapted to the area. The design of alternative production methods takes into consideration the physical and socio-economic site characteristics, the performance of the existing production methods and the available component technology for the crops and animals in the farming system. There are numerous practices which must be specified at the design stage. Many can be specified on the basis of existing knowledge and local methods. Others warrant separate experiments to establish optimal input levels or time and method of application. This component technology research may be conducted in national, regional, and local experiment stations or where possible in the farming systems sites.

5. Testing of alternative systems. This involves the testing of the designed systems or selected management components in their respective environments on the farm. Farmers participate in the testing by managing the crops and animals according to the designed methods, with frequent advice and constant monitoring of the research staff. Based on the biological and economic performance of designed systems, problems that limit intensification of production can be identified and fed back to discipline or commodity oriented researchers. This scheme helps orientate such research to solve relevant problems of the target farmers. The evaluation of alternative systems involves careful analyses of the performance of each component management change in terms of its contribution to farm productivity. Where possible, a whole-farm analysis has to be used to evaluate the performance of a number of changes in management components that constitute the alternative system under evaluation. Farmers' observations and their tendency to adopt changes in the study area are important means for the evaluation of alternatives.

6. Extrapolation areas. When acceptable production alternatives have been identified, greater benefits from these research results can be achieved by their extrapolation to a wider area. Identification of similar land types and confirmation of the suitability of the new production methods to those environmental homologues is a necessary step prior to extension activities.

7. Pilot Production program. The on-farm testing and the identification of extrapolation areas for the recommendation have at this stage provided substantial information about the performance of the new production methods. A pilot production program is often advisable before embarking on a large scale extension activity. Such a program generally starts off in the original testing area and has the objective to identify the institutional support and intervention required to assure the successful introduction of the recommendation. If successful, this experience will provide the information needed in the design of a full-fledged production program.

# CROPPING AND FARMING SYSTEMS RESEARCH IN INDONESIA

Suryatna Effendi and Jerry L. McIntosh [1]

## Introduction

The total land area of Indonesia is about 202 million hectares. Data indicated a total area of 5.8 million hectares of lowland paddy. Of this only 4.1 million hectares received some irrigation while the rest was swamp and rainfed lowland rice. If we include double cropping (MC Index of 1.5) about 94.4% of the rice production comes from this lowland paddy. In summary it appears that 94.4% of the rice production in Indonesia is grown on only 10.5% of the 55 million hectares of land considered suitable for cultivation (Biro Pusat Statistik, 1974).

The area for future expansion of irrigated land and even rainfed lowland rice is limited. The tidal swamps (pasang-surut) have received considerable attention as likely areas for expansion of lowland rice production. It is estimated that there are 18 million hectares of swamp land (not all pasang-surut) in Sumatera and about 19 million in Kalimantan. Several development schemes have been proposed. There are two main problems. Firstly, it is difficult and expensive to effectively control water to prevent flooding during the rainy season. Secondly, it is difficult to provide a high water table during the dry season to prevent aerobic decomposition of the organic matter and development of acid sulphate.

In contrast to the expensive and time consuming development of irrigation and drainage schemes, upland crop production could be started immediately and with little investment. There are approximately 18 million hectares of flat to rolling land between the mountains and coastal swampy lowlands in Sumatera and slightly less, or about 14 million hectares, in Kalimantan (World Bank, 1974). Much is abandoned to alang-alang. The question that the agriculturist must ask is this: "Can this vast area of land which is presently not used or, at least, underused be profitably cultivated for food production for a sustained period of time?"

## Background Idea

The problems that farmers face are always interrelated. Attempts to solve a specific problem may create new problems. This fact creates a dilemma for agricultural researchers. By training and temperament scientists like to simplify. A common technique is to study one aspect of a system while holding other factors constant. This technique is a powerful tool. Agricultural research in developed countries is usually directed toward disciplines of kind of crop or animal. This specialization permits in depth study of the components of a farming system. When carried to an extreme this approach becomes counter productive and produces a kind of research irrelevance. But fortunately extension and farmers are able to incorporate certain useful aspects of the research into the existing situation. However, even in developed countries there is a trend at present for scientists to devote more time and effort to systems research that address the immediate problems farmers face.

---

[1]Respectively Farming Systems Agronomist of the Agency for Agricultural Research and Development, and Cropping Systems Agronomist, Cooperative CRIFC/IRRI Program in Indonesia.

Unfortunately, the interdisciplinary, integrated and holistic approach to farm research sounds complicated. It does not fit the usual scientific approach that is commonly taught in colleges and universities. It costs a lot of money and takes considerable time and commitment. It is difficult to mobilize and maintain the interest of scientists because of the difficulty to establish one's identity, either personally or scientifically, in this kind of research. But for those who identify with farmers and their problems, this kind of research is highly rewarding. The reward is not monetary nor necessarily quantity or even quality of scientific papers, but in the realization that one is identifying problems and directly meeting the needs of people.

In addition to relevant problem-focused research, agricultural scientists should provide the technology and ideas for future agricultural development activities. It would be expedient for these scientists to do the research before they are requested to provide answers. The stimulus for agricultural development should come from researchers rather than the stimulus for research coming from development. In this way agricultural scientists will be able to serve the country better, bring credit to themselves and gain support to their research organization.

A comprehensive national farming systems program by definition should address the many situations that exist horizontally across the country and vertically within any system. All this is not possible to do at any one time. Some logical rationale must be established for priority, scope and depth of re-search.

Achievements

Indonesian cropping systems scientists developed a strong and comprehensive research and development program over the last 10 years. It has evolved into a farming system research program.

In collaboration with colleagues in the Asian Cropping Systems Network, methodology for effective interdisciplinary cropping systems research has been developed. Indonesia has demonstrated the effectiveness of the methodology for intensifying cropping systems on irrigated and rainfed lowland rice lands of Java and on the fragile and infertile upland soils of Sumatera, Kalimantan and Sulawesi. Except for the original research sites in Indramayu, west Java and Bandarjaya, central Lampung, most site selection for research has been in response to requests from various Indonesian development projects.

A team of interdisciplinary scientists has been trained and initiated through formal raining courses outside and within Indonesia and through experience in the field. These activities have provided a cadre of personnel that are now ready and capable of conducting comprehensive and phased research that can effectively identify and remove constraints that farmers face for increased crop production and economic well-being.

Farming systems research in transmigration areas and upper watershed projects has begun. A precedent for successful interdisciplinary research among all research centers in the Agency for Agricultural Research and Development has been established.

RESEARCH APPROACH:

Inventory of Resources

In addition to the traditional commodity and discipline oriented research

activities, we need to develop a systematic way of arriving at priorities for adaptive agricultural research for all disciplines within AARD.* The subsequent research should precede development projects and even provide the initiative for such projects. The first priority is an inventory of natural resources and the present agricultural situation. A series of maps presented in a sequence from the edaphological classification of land, through the physical determinants and finally to the individual food crops and farming systems would be very useful. It helps us see where we are and what research might have more relevance in all disciplines.

Edaphological Classification of Land

In this classification we attempt to delineate distinct land areas that differ based on the chemical and physical characteristics of the soil and water environment without reference to climate and other overlapping factors such as slope or land form. As a first approximation, based on experience and data available, the following classifications are used for Indonesia. In each case the amount of land area for each classification should be included, if possible, on an island by island basis.

A. Upland areas.

B. Lowland rice areas.

1. Irrigated - The following subgroups may be put together for a national map.
   a. Fully (10 months)
   b. Partially (7-9 months)
   c. Partially (5-7 months)
2. Rainfed lowland

C. Swampy areas (lebak)

D. Tidal areas (pasang surut)

E. Mangrove areas

Environmental Determinants

In this section are some of the most important environment factors which determine the suitability of land for crop production. These environmental factors may be looked upon as modifiers when used in combination with the edaphological map.

A. Soils map. Soils delineated should be those whose characteristics necessitate different land management practices. For example, differences in inherent nutrient status would not be a reason for delineating between two soils unless one soil required unusual amounts of fertilizer for corrective treatment.

B. Rainfall map. On a national scale the classification based on numbers of wet and dry months are sufficient. At working level (Kabupaten) the bar graphs which show monthly rainfall distribution are more useful.

*AARD = Agency for Agricultural Research and Development.

E. Elevation map.

F. Slope map.

Present Use Land Map

In development of land or research objectives within an area, the most significant data available are the present land use and information obtained from farmers.

The land use information delineated can be valuable in two ways. First of all it is useful to relate land use, by distinctly different crops or vegetation which have ecological needs, to a physical setting that can be characterized. Further breakdown by crops or species of plants provide the "standards" for evaluating land capability. They give some bases for modification of present land use or extrapolation of a particular kind of land use into new areas having similar agro-climatic conditions. Secondly, production figures for different food crop commodities from different areas of the country provide a basis for comparison. If production in areas with similar agroclimatic conditions differ greatly, we are provided with an ideal problem for applied and basic research projects that have relevance. We have a rational basis for developing research priorities.

Topography

The potential of new areas for permanent upland cropping, whatever the soil type involved, is strongly influenced by slope, which governs the degree to which the soil surface is vulnerable to erosion under cultivation. Throughout Indonesia, five general slope classes of agricultural significance are recognized:

1. Swamp. A general term for all land liable to inundation where the primary requirement for development is control of drainage.

2. Slope 0-3%. Land, soil and climate permitting, capable of being safely developed for annual cropping with little or no modification to surface geometry.

3. Slope 3-8%. Land capable of being safely developed for annual cropping provided surface geometry is modified by terracing, contouring, etc. to control surface water flow and associated soil loss.

4. Slope 8-15%. Land suitable for annual cropping but which may be safely developed for perennial tree crops.

5. Slope more than 15%. Land unsuitable for agricultural development.

Slope may interact with soil type in that, at a given slope, some soils are more prone to surface water movement than others owing to differences in permeability, and/or are more liable to erosion because of differences in stability of the soil surface.

A summary of slope data for most of the other islands is given in Table 1. Out of a total area of 162 million ha (85% of the total for Indonesia), only 10% is in the 0-3% class and 6.8% in the 3-8% class. Thus, by this estimate,

80% of the upland area of the Other Islands is considered unsuitable for permanent annual cropping on the basis of slope alone, without reference to soil type. It should be borne in mind that the areas referred to in Table 1 comprise both occupied and unoccupied land; the categorization of unoccupied land by slope is considered as Land Use Potential.

Table 1. Land in the Other Islands classified by slope*

| Region | Slope class | | | | | |
|---|---|---|---|---|---|---|
| | Swamp | 0-3% slope | 3-8% slope | 8-15% slope | 15% slope | Total |
| | (1,000 ha) | | | | | |
| Sumatera | 13,211 | 8,491 | 4,102 | 1,844 | 19,712 | 47,360 |
| Kalimantan | 12,764 | 3,693 | 4,778 | 3,308 | 29,402 | 53,946 |
| Sulawesi | 469 | 955 | 806 | 927 | 15,747 | 18,904 |
| Irian-Jaya | 12,980 | 3,606 | 1,288 | 844 | 23,477 | 42,195 |
| Total | 39,424 | 16,745 | 10,975 | 6,923 | 88,338 | 162,405 |
| Percent | 24.3 | 10.3 | 6.7 | 4.3 | 54.4 | 1000 |

Climate and Temperature

As a consequence of its latitudinal spread across the equator, the climate of Indonesia is either wet tropical or monsoonal. The amount of rainfall declines from the wet tropical land masses of Sumatera, Kalimantan and Irian Jaya to the drier monsoonal climates of Java and the eastern islands. Virtually all of Sumatera, Kalimantan and Irian Jaya experience less than 3 months of the year with less than 60 mm of rain. Total annual rainfall varies from nearly 5,000 mm to less than 1,000 mm throughout the archipelago, but the major concentration of crop production is in monsoonal climates in rainfall zones of 1,000-2,500 mm with a single dry season 3-6 months duration.

Average annual temperatures at sea level do not vary greatly throughout the archipelago. Mean annual maximum and minimum temperatures normally are in the range 31-33 C and 22-24 C respectively. Seasonal temperature ranges are also narrow, being less than the diurnal range, and broadly speaking, except at high altitudes, temperature is not a major factor limiting the growth of the main food crops at any time of the year. Seasonal cropping patterns are thus governed almost wholly by rainfall duration, irrigation and soil water storage capacity, and the range of food crops grown is virtually the same across the whole of Indonesia. There is, as might be expected, a greater proportion of rice grown in the wetter region. Corn production is associated with the drier regions. The location of cassava production shows no clear relation to rainfall.

*Source: Muljadi, D. (1977). Sumber daya tanah kering, penyebaran dan potensinya untuk kemungkinan budidaya pertanian. Kongres Agronomi.

Land Capability

Mapping of the land resources of Indonesia as a whole specifically for the purpose of agricultural development is still evolving. To meet the need for getting information of Indonesia's land resources for development it is necessary to proceed in an orderly and logical fashion, from the reconnaissance of large areas to the selection and survey in greater detail of specific areas, involving the integrated assessment of soil, topography, climate, etc., with the results extended and refined. This effort should be done by a team composed of soil scientists, geomorphologists, ecologists, agro-climatologists, hydrologists and to a lesser degree economists.

Current Land Use: General Land Use

Agricultural land under annual crops is divided into sawah and upland. Sawah is defined as land within bunded fields in which rice is grown under flooded condition (but in which upland or secondary crops such as corn, cassava, sweet potatoes, peanuts, soybeans, etc., may also be grown, under non-flooded conditions, as part of the rotation). The term upland in Table 2 covers all areas under annual crops excluding sawah land. Since in Indonesia there is virtually no irrigation of fields that are not constructed as sawahs, the term upland when applied to physical land areas signifies land used for rain-fed cropping.

Table 2. Summary of estimated land for annual crops 1981*

| Region | Sawah** | | | | | |
|---|---|---|---|---|---|---|
| | Irrigated | Rainfed | Swamp | Total | Upland rice | Total |
| Java | 2,628 | 377 | - | 3,004 | 1,530 | 4,534 |
| Sumatera | 776 | 238 | 169 | 1,182 | 713 | 1,894 |
| Kalimantan | 54 | 189 | 331 | 575 | 540 | 1,115 |
| Sulawesi | 266 | 83 | 1 | 349 | 393 | 742 |
| Maluku and Irian Jaya | n.a. | n.a. | n.a. | n.a. | 130 | 130 |
| Bali and Nusa Tenggara | 301 | 99 | - | 400 | 432 | 832 |
| Indonesia | 4,023 | 986 | 501 | 5,510 | 3,737 | 9,247 |

*Excludes smallholder and estate perennial crops, pasture, forest and fallow.

**The term sawah refers to rice fields, irrigated or watered only by rainfall, which have low banks or "bunds" built around them to retain water.

The total area in Indonesia under annual crops, both sawah and upland, is thus estimated at 9.2 million hectares. In Java 66% is sawah and 34% upland, and in the Other Islands 53% sawah and 47% upland, However, certain provinces in the Other Islands, for example Aceh, West Sumatera, South Kalimantan, South Sulawesi and West Nusa Tenggara, show a high proportion of sawah to upland.

The planted areas of estate and smallholders by crops are shown in Table 3.

Table 3. Planted areas of estates and smallholder by crops 1979*

| Crops | Estates | Smallholders | Total |
|---|---|---|---|
| | (1,000 ha) | | |
| Rubber | 443.4 | 1,858.6 | 2,302.0 |
| Tea | 66.6 | 36.0 | 102.6 |
| Coffee | 38.3 | 455.4 | 493.7 |
| Oil palm | 229.2 | - | 229.2 |
| Chinchona | 3.6 | - | 3.6 |
| Sugarcane | 167.7 | 118.7 | 286.4 |
| Tobacco | 9.4 | 137.5 (local)<br>35.8 (Virginia) | 182.7 |
| Fibre | 0.6 | - | 0.6 |
| Cocoa | 14.6 | 6.8 | 21.4 |
| Coconut | 17.5 (in 1975) | 2,386.7 | 2,404.2 |
| Nutmeg | - | 51.4 | 51.4 |
| Cassiavera | - | 69.7 | 69.7 |
| Pepper | - | 58.3 | 58.3 |

*Source: Central Bureau of Statistics

Area and percentage of the forest by its function in Indonesia is resented in Table 4.

Table 4. Area and percentage of the forest by its function in Indonesia

| Forest function | Area in 1,000 ha | Percentage |
|---|---|---|
| Protection Forest | 14,181 | 11.60 |
| Production Forest | 63,162 | 51.68 |
| Nature Conservation | 7,910 | 6.47 |
| Reserved Forest | 36,974 | 30.25 |
| Indonesia | 122,227 | 100.00 |

Forest Selection of Target Area

Farming systems research is a coordinated and integrated effort to develop technology that will enable farmers to increase production. The technology must be acceptable to the farmers who will use it. In some cases it may be desirable to identify and remove constraints to the farmers through government programs. The increased production may result from better management of present farming systems, introduction of an extra crop(s) or form of husbandry per year (intensification), or expansion of agricultural activities into newly opened under-used land areas (extensification).

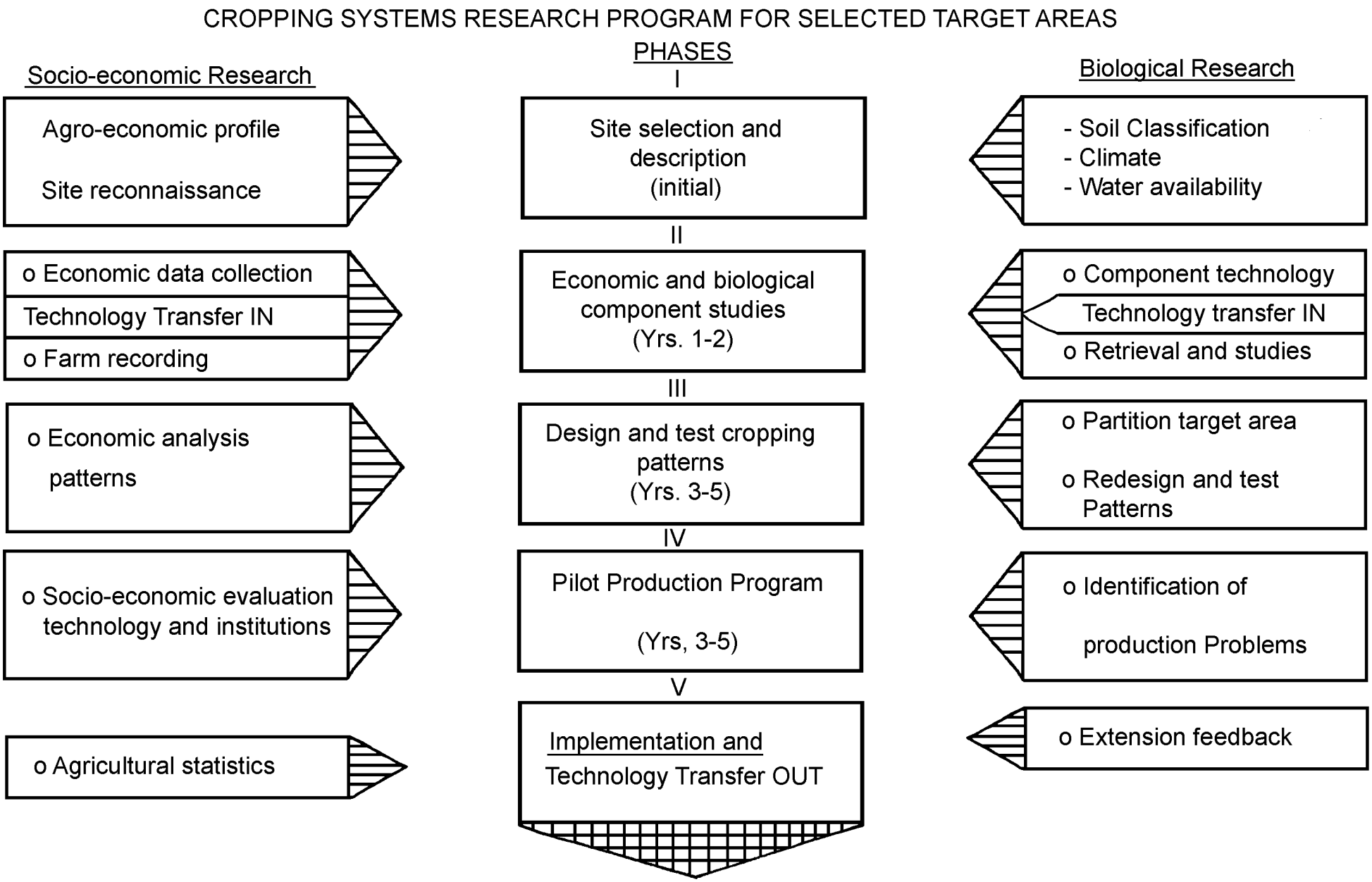



Fig. 1. Parallel biological and socio-economic activities required for the five distinct research and implementation phases of a cropping systems program with little inflow of technology.

The research is carried out by a coordinated group of scientists from various disciplines. It is focused upon specific target areas to make more efficient use of research staff and funds. The selection of target areas for farming systems research is very crucial. The Indonesian program emphasizes the following criteria for selection of target areas:

1. Critical areas in terms of food shortages and governmental designation.

2. Large areas having similar soils and climate.

3. Feasibility of intensifying cropping patterns and farming systems based on prior evidence.

4. Availability of markets and infrastructure.

A diagram for cropping or farming systems research in Indonesia (Figure 1) shows five distinct phases, associated research activities and approximate time frame that follow after selection of the target area.

The present concentration of food crop production on Java is largely a reflection of the abundance of soils of volcanic origin, together with the relatively fertile lowland alluvial soils. Historically, these soils have permitted a steady increase in cropping and hence human population on Java from estimated 5 million in the early 19th century to the current 80 million. The increase in population has been accompanied by a progressive intensification of land use in both lowlands and uplands to the point where Java may be considered as fully exploited for cropping. There are areas in Java which should be retired from annual cultivation and put under a permanent tree cover, for the protection of catchments draining into more closely settled lowland regions. Although there is scope for intensification on Java, the future expansion of the area under food crops will occur almost exclusively on the islands outside Java.

With respect to the Other Islands and the development of new land, interest centers on the swamp soils (about 24 million ha) and the red yellow podzolics and their associated complexes with other soils (about 48 million and 54 million ha respectively). The swamp lands are largely located in Sumatera, on the eastern flank, in Kalimantan and in Irian Jaya. Red-yellow podzolics and their associated complexes are also found mainly in Sumatera, Kalimantan and Irian Jaya; in addition, the complexes are well represented in Sulawesi.

Edaphic Target Area

Target areas for farming systems research may fall within one agro-climatic region or a distinct edaphological land area. For farming systems in which crop production is dominant, we attempt to delineate distinct land areas that differ based on the chemical and physical characteristics of the soil and water environments. For example, land for lowland rice is different from land for upland rice even though the soil, climate and other overlapping factors such as slope or land form may be the same. This approach is very useful for developing cropping systems technology across political boundaries. This is the basis for specifying the characteristics of national production programs for upland crops, irrigated lowland rice and rainfed lowland rice. Consequently, for food crop based farming systems research, the identification

and delineation of the following edaphological conditions is useful such as: A.Upland; B. Lowland rice: irrigated, partially irrigated and rainfed; C. Swampy; D. Tidal (pasang surut) and E. Mangrove.

Development Target Areas

In many instances the target areas will be in less developed regions and consist of many different ecological conditions. This is true for many new transmigration, watershed, and rural development projects delineated by policy decisions. Because we are dealing with farming systems, as a priority land not suitable or not designated for settlement and use by small farmers should be delineated. The delineation of conditions might be as follows: A. Forest and wildlife preserves; B. Forest concessions; C. Range land for animal production; D. Perennial crop estates; E. Farming systems; 1. Mixed farming, 2. Food crops based.

Research

Traditionally agricultural research has been organized and administered according to disciplines and crop commodities. This approach is useful and will likely continue to provide much of the technology for the basic components of cropping and farming systems.

It has become evident that identification of more specific research issues is desirable to provide guidance to research administrators for concentration of research personnel and funds. Cropping systems research has identified specific research issues that need further study and has "fed back" this information to the institutionalized research centers.

At this stage in the development of cropping and farming systems research, the present status and some priorities for further research may be outlined as follows:

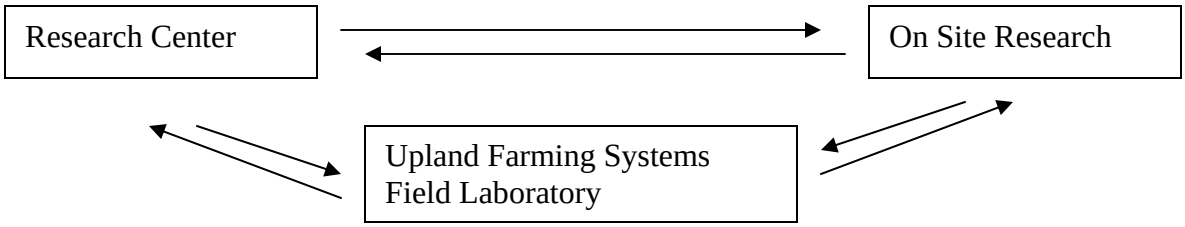
Rainfed upland agriculture --

a. Food crops agriculture is needed but primarily for subsistence.
   Status: Basic cropping patterns have been identified and Research Centers will continue to provide component technology.

b. Other agricultural enterprises in addition to the food crops component are required to raise the standard of living.

   Status: Farming systems research is needed to identify the next most appropriate farm activities and the relative proportions of each component to be included in the systems.

c. Upland farming systems components need more development and testing before evaluation on site. An upland Farming Systems Field Laboratory is needed to provide the environment for such research.



d. Upland areas of Indonesia may be conveniently divided into the following categories for research purposes.

Humid upland rainfed areas
Drought prone areas
Upper river watersheds

Lowland rice areas --

a. Cropping systems research has developed strategies and cropping patterns for these areas. The strategy is to grow lowland rice wherever feasible and follow with legumes.

Status: Institutionalized rice research is sufficiently strong to continue to supply technology for this crop. Technology for legumes is available, but support in terms of seed supply and distribution is weak. Mater management to facilitate introduction of soybeans in the cropping patterns, for example, need more on site study.

b. For all three categories: irrigated, partially irrigated and rainfed lowland rice lands, water management is a most important research issue at the present time.

Deep water and tidal areas -- Present research is preliminary and will provide the bases for future in-depth research.

Research activities on irrigated land have been underway for a long time, while little has been done on rainfed upland agriculture. The focused of this paper will be primarily farming systems research and development on rainfed agriculture.

Rainfed Agriculture

Development of rainfed agriculture was adopted and reaffirmed as a major priority area of action in Indonesia. Technical complexity of this task was well recognized and several lines of priority action were recommended.

We recognized that much remained to be done to translate scientific break-through into compareable increases in production and prosperity at the farm levels. It emphasized the need to work at levels closer to the attainable possibilities within the predominant framework of small farms and institutional constraints in Indonesia and to arrive at a level of improved technology entailing lower expenditure and risks and, therefore, more accessible to small farmers.

The choice of Development of Rainfed Agriculture as one of the priority areas was welcomed to improve the imbalance of income growth and welfare gains between farmers in the irrigated lands and the majority of the farmers whose lands were dependent on rainfall. An approach on a wide front was needed, covering research, training, demonstration and development projects, etc. The need for crop saving research and the efficient use of fertilizers are very important.

The Development of Rainfed Agriculture, with special emphasis on appropriate cropping systems and soil management, was reaffirmed as one of the priority areas, since it affects 80% of the arable land in Indonesia. The scope of rainfed areas was extended to include not only high rainfall humid areas but also rainfall semi-arid areas.

For increasing and stabilizing agriculture production in rainfed areas, the following recommendations, among others, are made (a) definition and uniform classification of rainfed regions based on climate factors, physiography, soils, and vegetation, (b) analysis of hydro-meteorological and ecological factors for designing and selection of cropping systems, (c) breeding of high yielding varieties suitable for rainfed areas, particularly deep water rice, and seed production and distribution of identified varieties, (d) sound soil and water conservation and management practices, (e) mixed farming, integrating crops and livestock, (f) fuller utilization of atmospheric nitrogen, organic manures and plant residues, (g) farm machinery and agricultural tools research and development.

It is observed that increasing yield stability rather than record yields is the goal, that small increases over large areas make a more significant contribution than high yields on a few farms, and that there should be a shift in emphasis from the individual crops to the environment and the systems it has generated. The failure of improved varieties to stand the environment or fit the farmers' real needs and the neglect of animals were areas of great concern.

Under Development of New Technology it is emphasized particularly (a) development of flexible approaches to crop production with the aim of increasing yield stability, (b) identification of critical inputs rather than adoption of an unselective "package" approach, (c) improvement of food legumes, oil seed and vegetable crops by fitting them into farming systems of the staple cereals, (d) increasing efficiency of fertilizers and complementary sources of plant nutrient, (e) breeding for varieties to suit "non-ideal" conditions, (f) improved seed technology and seed supply and simple local seed storage at the farm and village level, (g) integrated approach on land management techniques, farming systems and small farm mechanization.

Priority Action Areas for Crop Production Research

In recognition of the fact that the weaker section of farmers, generally on small holdings, predominate in agriculture in rainfed areas of Indonesia, and that the first concern of such farmers is to raise food crops to meet their family needs, this will restricted to the major food crops of the region. By doing so, the export crops on which the economy of the country depends, the tree crops which are a feature of the humid tropics and so essential to protect the land, and the animal husbandry whose integration with arable farming is essential to improve the economy of the small farmers are also considered.

Description and delineation of agro-ecological zones within Indonesia are a prime necessity, The necessary expertise to undertake detailed work on agro ecology is not available within the agency, and the task has to be remitted to a specialist team of climatologists, hydrologists, soil scientists and agronomists. Meanwhile, using the already available information, the urgent need is to arrive at a broad working description of the various agro-ecological zones within Indonesia based on climate, soil, physiographic units and vegetation.

Most of the increases in food production came from the irrigated lands through increased fertilizer use and cropping intensity. Even so, there is a great scope to increase the productivity of the non-irrigated areas. Since there are no separate statistics on area and production of the rainfed areas, it was not possible to estimate the contribution and progress made in the rainfed areas.

Reviewing the national systems of research, it is necessary to reiterate that a high priority should be given to rainfed agriculture at the policy and planning, implementation and coordinating levels. It was recommended that an interdisciplinary team be organized within the country to serve as a national team on rainfed agriculture and to coordinate the research activities of the various agro-ecological zones coordination/implementation cell). Since the problems of rainfed agriculture are location (situation) specific, unlike in irrigated agriculture, programme execution should be at selected centres representing the major agro-ecological zones. To this end, the establishment of a network of small but functional stations linked preferably to a well equipped research centre in the area is strongly recommended. To maintain continuity of work, a five-to-ten year programme should be drawn up with well defined goals, subject to annual review of objectives, priorities and shifts in emphasis.

Once the Governments show interest in and support distinct programmes on rainfed agriculture, external assistance may be expected.

To start with, the existing national research programmes may be reoriented with emphasis on rainfed farming. The emphasis should be on problem oriented field research.

Research Programmes

It is found convenient to discuss the national priority areas of action for research and development under two heads, namely, crop based and area based.

| Crop based | Area based |
|---|---|
| Varietal improvement | Benchmark/Survey |
| Cultural management | a) Soils |
| Crop protection | b) Climate |
| Crop utilization/processing | c) Existing practices |
| Economics/marketing | d) Socio-economic aspects |
| Social aspects | |
| | Resource conservation, management and use |
| | a) Output/income maximization |
| | b) Risk minimization |

The contrast between irrigated agriculture, in which the farmer has the critical input, water, under his control and the rainfed agriculture was sharply focused upon; the differences in the needs and requirements of the two farming situations became obvious. For example, the strong crop based research programmes, which predominate today, provided the foundation for successful production programmes in irrigated agriculture but have been found inadequate for meeting the needs of rainfed agriculture. The cultural operations are time-

critical in rainfed agriculture, where as considerably more flexibility in timing the operations exists in irrigated agriculture. The kind of contingencies which have to be provided for are far more numerous in rainfed agriculture. Perhaps the most vivid contrast is in the area based research. In irrigated agriculture, the objective is maximization of resource use while in rainfed agriculture this approach should be tempered with risk minimization.

Area based research and development needs immediate strengthening in Indonesia. Within the crop based research, cultural management and crop protection, especially weed control, needs more attention.

Crop Based Research

In rice, the most important crop of the region, suitable varieties were not yet available for either upland or deep water conditions. There is no water control in such areas, and yields are poor.

In conclusion, the crop improvement programmes have by and large confined themselves to breeding of new varieties suitable for assured conditions, with all the emphasis on high yield and more recently on pest and disease tolerance. Difficulties were faced immediately when these varieties were extended to "non-ideal" environments where the farmer has no control over the amount and timing of inputs, particularly water, that is, under rainfed conditions. Also, preoccupation with high yield and elite varieties resulted in the varieties not fitting into the existing farmers' cropping patterns. It is not the intention to say that breeders should stop looking "beyond the horizon" but the plea was for them to pay more attention to realities outside the experiment stations.

The first step is to arrive at the specification for crops and varieties that would be suitable for a given situation. The specification consists of duration, specific and non-specific stress and to some extent consumer preference. This "non genetic" aspect of crop breeding cannot be over-emphasized. It would be beyond the breeder alone to arrive at the specification. A team consisting of climatologists, agronomists, extensionists and practicing farmers will be suggested.

The second step is the actual breeding for the needed varieties. This is to sole domain of the breeders.

The third step is to test the specified varieties at selected locations situations/environments). It is preferable to have entries of established yield potential as the base from which a choice is to be made. Multi-location testing helps to identify in a short-time the suitable varieties.

The final, and the most important, step is to grow the suitable varieties on farmers' fields and under farmers' condition so that farmers can make their choice.

Cultural Management

The objectives of Cultural Management are (a) to achieve the full production potential possible within the constraints of the environment and (b) to stabilize the production.

A farmer has to do the following operations in order to grow a crop: tillage, seed bed preparation, sowing, and weed control. There is a wealth of

agronomic information on dates and rates of sowing and row widths. It should make it possible at the farmers' level to adopt simple but effective agronomic recommendations on low cost inputs. There is hardly any information on the energy requirement for the major components of rainfed farming operations and ways and means to reduce the over-all energy requirement relevant to small farmer.

Agro-ecological Zones

Area Based Research (Research Based Research) the most important research in order to meet the location (situation) specific needs which characterize rainfed farming. Even if crop based research is done on a typical location in the selected agro-ecological zone, there is the need to project the experience from the experimental location to the area it represents, recognizing and allowing for the variations of the resources in the area.

Aberrant Weather

The characterization of an agro-ecological zone is often considered as a one time and once-for-all job. This would be true when the concern is with planning at macro level for large areas for which statistical truths are valid. For smaller areas and for planning at the micro-level the variability is too high to rely entirely on the statistical truths. For instance, it is possible to characterize the climate of an area in terms of the historical data, the weather contingencies and their frequencies. It would, however, be necessary to set up on a continuing basis an agency which would interpret the weather information in readily usable form, diagnose the approaching contingency at the earliest possible opportunity, suggest remedial measures and indicate as early as possible shortfalls for which the country should be prepared. In short, set up a group of interdisciplinary scientists to watch the weather and progress of the season.

Resource Conservation

A vital aspect of area based research is the resource conservation, management and use, including resources of farm animals and crop plants, of soil, of water, and, in fact, of human resources.

Resource conservation is beyond the scope of single individuals, much less the rainfed farmers whose holdings are small and scattered. For instance, it is too much to expect an individual farmer to appreciate the need for protecting catchments beyond his farm boundaries. It is better that resource conservation in the rainfed areas should be taken up as national programmes.

In this connection, a reference should be made also that phosphorous deficiency should be regarded as a "policy" issue. Drainage, irrigation, road networks are all accepted infrastructure needs to be carried out at government expense. The case is strong for taking up the use of phosphorous and other nutrient elements which have a strong residual effect as a national programme.

Cropping Intensity

A particular useful area of research in the tropics for improving the resource management and use is cropping patterns. The objective is to increase production so that farmers will have some marketable surplus, diversify crops, protect the soil, distribute and minimize risk, and generate employment opportunities, Starting from the low rainfall areas where only a single crop is all that could be grown, the cropping patterns have become progressively more complex as the rainfall and duration of the season increases. With slightly better rainfall, intercrop systems are the most appropriate. Both intercropping in space and in time are possible. Basically intercrop systems in time are more productive. Accepting this, crop geometry could be introduced as a variable depending on the objectives of the farmers. The first approach is to accept the major crop of farmer's choice and develop intercrop systems such that the yield of the major crop is not significantly reduced; the minor crop will then be a bonus. Such systems as a cereal and a short season legume--soybean for example--are best suited for fortifying the food and feed with additional protein. Recent studies have revealed that for obtaining best results, the population of each of the component crops should be maintained at its optimum.

Crop diversification itself reduce the risk. As a rule delay cropping is most appropriate in areas where land must be protected all the time during the rainy season against splash erosion. Other advantages are avoiding preparatory tillage for the second crop and planting it at a time when there is good moisture in the seeding zones.

The crop options open for improving cropping intensities in rainfed areas are rather limited. Hence the first step is to promote crops which the nation needs and the government is promoting and to assure at least one good crop before attempting to introduce cropping patterns. The system should be easy to work and be flexible with several alternatives. The primary human need is food. It is possible to integrate this requirement with others. In the semiarid tropics crops, livestock and wood for fuel should be integrated. In the seasonally dry tropics, crops, cattle and fish and in the humid tropics, trees, crops, cattle and fish may be integrated in the farming systems.

In developing farming systems relevant to the total environment it is best to commence with the improvement of the traditional systems that are already popular under the indigenous conditions of the area. In designing research programmes examine the possibility of working at two assumed levels of infrastructural support systems. One at the advanced level would assume that provision of the infrastructural support system is such that there is a possibility of substantially changing the farmers' methods.

Concepts for cropping pattern design in farming system. In some instances, cropping systems research is simply the testing of many cropping sequences in the farmers' fields under different environmental conditions. The approach used in Indonesia has emphasized the testing of patterns designed on the basis of concepts. The actual crop sequence used for each conceptual pattern depend upon the level of technology sought or available.

Three conceptual cropping patterns were tested in each category for each target area when the Indonesian program started in 1975. Each trial was replicated three times but by different farmers (or across farms). The cropping

sequences for a pattern tested in each category were not necessarily the same, but were selected on the basis of the same criterion. The criteria for selection of the sequence of crops and management practices for each pattern and the rationale for each criterion were as follows:

1. Criterion A. Farmer's present cropping pattern

   Rationale: To establish a base-line check for comparison

2. Criterion B. Farmer's choice of cropping pattern if input and market constraints were removed

   Rationale: To evaluate the farmer's level of competence and managerial skill and perhaps uncover hidden socioeconomic constraints

3. Criterion C. Our introduced cropping pattern with input and market constraints removed and technical assistance provided

   Rationale: To determine production and economic potential and our ability to remove constraints

The use of these criteria for design of cropping patterns has been successful. It has allowed us to be objective. We do not get bogged down in evaluating small differences in results from using different species of legumes or varieties of rice in testing many different cropping sequences. These refinements are necessary, but are the kinds of components studies that are never finished. In our studies, however, we have been made aware of the severe economic stress faced by many Indonesian farmers. They simply do not have money they can use for material inputs. If they do, they are afraid to take the risk. This is particularly true for farmers who have seldom worked with the extension service. We feel we must develop low input patterns for new adopters. If the technology is good and shows evidence of being profitable, they will soon learn how to use more inputs. We now recommend the following criteria for design of cropping patterns:

1. Criterion A. Farmer's present cropping patterns (monitor only)

   Rationale: To establish a base-line check for comparison

2. Criterion B. Farmer's cropping pattern with inputs and optimum management

   Rationale: To evaluate the farmer's pattern without input and managerial constrains

3. Criterion C. Our introduced pattern with low inputs

   Rationale: To Induce the farmer to gradually try new technology

4. Criterion D. Our introduced pattern with input and market constraints removed and technical assistance provided

   Rationale: To determine production and economic potential

Strategies for design of introduced patterns in a farming system. The impression that evolved from accumulated survey, soil classification, climate, and market data and from observation of farmers' patterns is the best guide for cropping pattern design. If nothing appears obvious to the Cropping Systems Working Group after this exercise, it would probably be better to work somewhere else. Among the techniques used by cropping system scientists to intensify cropping and increase production there is a thread of commonality. The techniques used for the lowland rice-producing areas of Asia are shown in Table 5.

These specific examples are useful in understanding how the role of intensification can be tackled. More generalized guidelines for pattern design may be useful for situations where less is know.

Table 5. Common strategy for crop intensification in lowland rice areas.

Fully irrigated. Go from 2 to 3 crops per year.

1. Plant earlier in crop year.

2. Use earlier maturing varieties.

3. Reduce turn-around-time between two consecutive crops.

4. Tailor inputs to soil, climate, and crops.

Partially, irrigated and rainfed. Synchronize plantings to permit an extra crop per year.

1. Plant earlier in crop year by direct seeding and use of minimum tillage.

2. Reduce turn-around time between two consecutive crops.

3. Plant earlier maturing varieties of rice and other crops.

4. Plant upland crops other than rice during dry season after harvest of lowland rice.

5. Plant early maturing upland crops at beginning of rainy season before there is enough water for lowland rice.

6. Use year-round crop production and soil management practices. This will reduce labor needed for tillage and weeding and ultimately contribute to crop intensification.

A. Selection of crop to be grown. New or exotic crops are likely to be unsuccessful when first introduced. Initial phases of a cropping systems program will be dependent upon the use and improvement in production of familiar and marketable crops. Gradual introduction of new crops can be one of the most important strategies for cropping systems research.

1. Agronomic adaptation. This is an important consideration for selection of crops to be included in new cropping patterns. The crop must fit the rainfall

and its distribution (or irrigation) during the time of the year the crop is to be grown. Usually food crops receive the highest priority for government support in developing countries. Of these crops, rice is the most valued in Asia and, consequently, is grown if possible. Corn is usually the best highest valued crop and could be grown under drier conditions than rice. Sorghum and millet are usually more drought tolerant than corn and rice but many times are not as adapted to acid soil conditions. The versatility of upland rice, in this respect, has not been fully exploited. The root crops, sweet potatoes and cassava, can fit into most patterns for upland areas. These are usually high-valued, fresh-market crops near cities and subsistence food crops in remote areas. Cassava is an especially stable crop in drier regions and times of the year. Legumes usually grow well at the beginning of the rainy season when disease and insect problems are less. Many of the legumes are photo-period sensitive and this must be taken into consideration. In irrigated areas, legumes usually are cash crops to utilize residual soil moisture after lowland rice. Seeds produced at the beginning of the rainy season in adjacent upland areas may be used as seed sources for the lowland areas. Seed viability is a problem, particularly for soybeans. Their value as a protein source must be given high priority, particularly in remote upland areas where sweet potatoes, cassava, and other starchy food crops make up a major portion of the diet.

2. Market and market potential. Farmers grow food crops to feed their families and to sell. The first priority is for food. The incentive to grow extra crops for marketing purposes depends upon the profit the farmer can make. In most developing countries there are government policies to keep food prices low. These policies benefit the large number of consumers in the cities and towns but hinder efforts to increase agricultural production. These problems have been recognized by most governments and attempts are being made to establish and maintain minimum market prices.

Since rice is the preferred crop in Southeast Asia, it is usually the most profitable crop to grow. Other crops (unfortunately referred to as secondary crops) may be much less profitable especially if they cannot be easily processed within the country or exported. Corn, cassava, soybeans, mungbeans, and peanuts usually offer the widest range of market potential.

B. Management of cropping sequence. The prevailing farmers' cropping patterns usually give the best clues to the opportunities and constraints face by farmers. Good surveys can help pinpoint and clarify many socioeconomic as well as agronomic conditions that affect the farmers' decisions.

1. Minimize risk. This concept is especially important in remote or newly opened areas where the farmer must be self-sufficient and can expect little help from government agencies. These are the conditions under which farmers many times use complex mixed cropping combinations and little material inputs. In partially irrigated areas farmers are reluctant to grow a second crop of rice and if they do they usually reduce fertilizer and labor inputs. These evidences of the farmer's understanding of risk must not be ignored. We design and test improved patterns which require low levels of material inputs. At the same time similar patterns are designed and tested with what we expect to be agro-economic optimum levels on inputs. In this way we can develop technology with a broader base and gradually introduce it at a level farmers can more readily accept.

2. Minimize and distribute labor. Power for land preparation is a major constraint to increased crop production through intensification in upland areas. A farm family can prepare only about 0.5 to 0.6 hectare of land by hand labor at the beginning of the rainy season. Labor is also a constraint in partially rain-fed areas where time is a factor in getting the land prepared for planting rice at the beginning of the rainy season. Design of cropping patterns to utilize available water can be an effective technique to save labor. The introduction of extra crops usually induces more land cultivation and competition for weeds. The farmer benefits by the reduction in labor requirement for land preparation and weeding per crop and the opportunity for gainful labor during times of the year the family would be idle.

3. Distribute cash flow. New cropping patterns must take into account the farmer's economic situation. In newly opened upland areas farmers usually have less money available for purchase of inputs than farmers in the lowland rice-producing areas. In either case there is generally financial stress. Recommendations for larger inputs are not likely to be adopted unless the new technology is gradually introduced and arrangements are made for credit. Farmers who have never had much cash are not usually willing to make use of credit when it is first offered. Gradual introduction of technology represents one strategy to overcome this reluctance. Consequently, in addition to "optimum patterns," cropping patterns should be designed for developing low and intermediate levels of technology. If the lower levels of technology are adopted by farmers and found beneficial, they will likely be willing to assume the responsibility for more credit and inputs.

Cropping patterns which involve more crops and harvests usually provide for better labor distribution and even out the cash flow for production costs and income from sale of marketable produce. The farmer may have less money for short periods of time but some money over a longer period. He is more likely to have some money for food and for production inputs when needed.

## Testing Cropping Patterns in a Farming System

The cropping systems approach to research has developed for several reasons. But some of the original work was done to study two basic questions in tropical agriculture--how to utilize more efficiently the tremendous energy, land, water, and labor resources available and how to get farmers to adopt the technology developed.

Rationale for systems research. The physiological, agronomic, and technical aspects relating to the first question may be studied in the laboratories and research stations. The potential for total production is evident from this kind of research even if many times the technology is inappropriate for adoption by small farmers of the less-developed countries (LDCs) of the tropics. The contrasting situations between the developed and less-developed areas of the world must be recognized even if there is a problem of oversimplification. In developed countries where farmers are likely to be better educated and economically stronger, published and disseminated research information may be sufficient to meet the farmer's need. The farmers are able to apply the technology, assume the risk and evaluate the technology within their context. In developing countries, however, farmers may be under-educated, financially weak, and afraid to assume the financial risk and peer pressures associated with change. The technology must be developed and tested systematically and extended to the farmers in a simplified form.

Production programs have been developed and financed to solve some of these problems. Technological packages were made available to farmers with credit facilities through such programs as MASAGANA 99 in Philippines and BIMAS in Indonesia. Production was increased for individual crop commodities. These steps forward were very successful, even though many farmers did not greatly benefit from the efforts and many did not continue to participate. The basic problems of development and adoption of appropriate technology by farmers were not solved by the production programs.

Before these programs for crop commodities and cropping systems reach the stage of implementation, they should be preceded by research conducted under conditions approximating that of the farmers. The research and implementation must be target-area specific. The first step, as has been described in this paper, is to conduct preliminary research in the farmer's field under the researcher's management to get some idea of crop performances and production potential within a target area. If this looks promising, the cropping patterns that have been designed should be further tested in farmers' fields as much as possible under the prevailing conditions that exist.

Methodology used. Using this approach, the Indonesian cropping systems program has been effective in West Java, Lampung, South Kalimantan, and Southeast Sulawesi in developing and implementing research.

A team composed of a coordinator, agronomist, and economist was stationed in each target area. A system for collecting daily farm records for all farm buying and selling activities was implemented in cooperation with farmers (about 30) in each target area to get a larger base for socioeconomic evaluation.

The organization of the research and research team should be as simple and self-contained as possible. The coordinator should have flexibility in implementing the research once the general guidelines for trials, patterns, organization, and staffing are decided upon. He or she should have mobility to visit the sites and research plots frequently, talk with the farmer co-operators, and develop cooperation with the extension service and local government officials. He or she should assume the responsibility for summarizing and preparing a draft report of the research results. Most of all, he or she should, in consultation with staff, critique the research in progress and prepare a tentative project proposal for the following year. The involvement of those close to the field research activities is the key to successful and relevant research and staff development.

The Indonesian program has usually replicated the field trials across farmers' fields. This has been successful primarily because the target area had been stratified by partitioning the area into categories. For each cropping pattern tested, three farmers within a category were randomly selected as co-operators after screening based on criteria relating to land tenure, size of farm, cropping system, location, and desire to cooperate. Each farmer agreed to permit 0.1 hectare of land to be used for the research. He provided the labor, and the project provided the necessary inputs. The farmer was compensated for any losses and extra labor caused by the project. All data concerning labor and costs input were collected. The cash flow of the agronomic farmer co-operators and the other farmer co-operators were- monitored. The data were reported in terms of yields, gross returns, labor costs, material costs, and net returns for each pattern in each category. The data from economic farmer co-operators were summarized in the same way to establish more precisely the economics of the farmers' cropping patterns and to understand their farm operations.

Pilot Production Projects

In many countries pilot production projects are an integral part of the technology delivery process. Sometimes it is considered a research function and sometimes exclusively extension. In Indonesia, as Fig. 2, phase IV indicates, this activity has a legitimate research component, particularly for new research target areas. But it is recognized that in most instances it is largely an extension activity.

Pre-production testing. We would normally expect that the technology developed and tested by a research organization would be adopted by farmers with only dissemination of the information by extension workers and by development of production programs. The latter step is usually not necessary in developed countries where the agricultural economy may be strong. Even in less well developed countries, technology for new varieties and management practices for crop commodities may be directly and easily introduced. But for cropping systems research implementation, there will likely be a need for an additional research phase. This phase is more complex than indicated by this terminology. It is an evaluation not only of the appropriateness of the technology but also of the infrastructure. The weak links in the infrastructural chain should be identified and strengthened to absorb the new technology. This can be best illustrated by an example from the Indonesian program.

A. Methodology used. Research was begun in both Indramayu, West Java, and Central Lampung, Lampung, in 1973. Results from the first two years in Indramayu showed the feasibility of increasing crop production by introduction of high-yielding and early-maturing varieties and inclusion of an extra crop either before or after the main crop season. In Lampung, the results showed the potential for crop production and stable agriculture on the red-yellow podzolic soils of Lampung under rainfed-upland conditions. The research in these two areas was expanded in 1975 to include on-farm testing of farmers' and introduced cropping patterns in the three main irrigation categories of Indramayu (10 months, 7-9 months, and 5 months of water availability) and for partially irrigated (5-6 months water availability) and "newly opened" and "old opened" areas in Central Lampung. This research was conducted in close cooperation with the extension service and local government officials in hopes that the research results could be smoothly and quickly adopted by the farmers. During the third year (1977-78), the trials were not replicated but were consolidated into one contiguous area for each irrigation or land use classification (an embryonic Phase IV of Fig. 2). The idea was to test the introduced patterns in plots large enough to cover several farms and minor differences in soil and water availability and to gain visibility among farmers and extension workers.

B. Constraints identified. The data and experiences from the 1977-78 research verified previous findings. We felt there was sufficient evidence to support the development of Production (BIMAS) programs in these two target areas for cropping patterns rather than for individual crops as has been done in the past. The BIMAS program would help remove the credit, input and perhaps market constraints faced by farmers. But in order to be successful, all components of the production system would have to be synchronized. This would include synchronization of varieties, insecticides, planting and harvesting dates, time of arrival and termination of irrigation water, and local government activities. These infrastructural considerations are not so important when new varieties, insecticides, and other single-faceted technologies are introduced. But for cropping pattern changes, the constraints that have prevented the farmer from

modifying his systems in the past must be identified and removed. Furthermore, the new problems that arise from implementation of the new cropping patterns must be anticipated and removed. For example, increased production will cause marketing problems and overloading of the existing agri-business community. We feel that an expanded Phase IV is needed in the sequence of site selection, agro-economic potential, designing, testing and implementing new cropping systems technology for a target area. But we also recognize that this activity must be an integrated endeavor with other government agencies.

C. Institutional constraints. The pre-production or pilot production phase (Phase IV) should cover one or more of the smallest governmental units (Desa in Indonesia) within the target area. The planning could be coordinated by the Ministry of Agriculture in cooperation with the provincial planning agency (BAPPEDA in Indonesia) so that all relevant governmental agencies would be involved. In this way, the institutional constraints that might arise from introduction of the new technology could be identified (and removed) before wide-scale implementation was attempted. The coordination of the research, extension, irrigation, and local governmental agencies is vital if the pre- and post- production constraints are to be removed. This idealized kind of on-farm research would have been useful as a follow-up to the embryonic efforts we made in Indramayu and Lampung to solve these problems. These two target areas differ greatly in their stages of development and kind of agriculture. However, if the site descriptions are accurate and sufficiently detailed, research results could be applied (transferred) to other areas with similar agro-climatic conditions.

Test farms. The research approach used for the test farm does not necessarily differ from that described in this paper. The land tenure arrangement represents the major differences. The land is under control of the researchers and consequently, the researchers are more sheltered from the public and will likely conduct research more in line with tradition. But the security offered by a test farm arrangement permits development of research facilities, quarters and longer term experiments. Technology generated should finally be tested directly in the farmers' fields.

## Implementation Through Production Programs

The experiences with government-sponsored production programs in general have been good. An acknowledgement of the need for support to small farmers for development of appropriate technology, credit, production inputs, technical services, and markets has been made. These are steps in the right direction for developing countries. The prospects for this kind of governmental activity affects the research processes and the technology developed. If the farmers in a developing country are economically weak (and they likely will be) and the government is indisposed to support production programs, the agricultural research effort should be mostly directed toward low-input technology. This places a great constraint upon research options. Not much can be done to increase total agricultural production, but some techniques can be developed to conserve the soil and stabilize production. Hopefully, under the most austere circumstances some support can be obtained to remove the most severe constraints to production. Research should be directed to identify these constraints and develop technology that is within the economic grasp of the individual farmer. The methodology that has been described can be used for these different situations.

The experiences with production programs in the Philippines and Indonesia have been described in several publications. The important question is how to

make them more effective from a technical point of view. It is recognized that initially production increased each year after implementation of the programs. Then production began to level off. It is at this state that cropping systems research can be most useful. The technology developed for specific target areas permits more specific recommendations and higher production possibilities for these areas. This technology then becomes more acceptable and allows for transfer of technology to similar agro-climatic and economic regions. The transfer of appropriate technology may reduce the research time required in new target areas by 2 or 3 years (Fig. 3). Production packages can be tailored to better meet the requirements for increased production and farmers' needs.

Technology Transfer: Technology Flow

Vertical flow. One objective of a farming systems program is to use existing information by bringing it together and testing it in a specific environment. Technology of this kind usually comes from the experiment stations of national and international institutes and is fragmented according to crop commodities and disciplines. The technology is then transferred to the government bureaucracy and finally to the extension service. This is a kind of vertical transfer of technology. The information is disseminated by the extension service in a "trickle-down" fashion.

Horizontal flow. Improving the flow of technology (transfer of technology) is simply a way of using research funds, personnel, and time more efficiently. The concept is useful in that it provokes scientists to consider application and integration of new technology as a legitimate part of a research effort. This approach has not been fully exploited in most agricultural research and development activities that apply directly to farmers. Basic studies in soil science, biochemistry, plant physiology, and related fields usually are well described and documented. The technology developed can be transferred from place to place (horizontally) as well as vertically. The technology of the applied agricultural sciences (such as agronomy, horticulture, and forestry), which directly affects the farmers' welfare, usually consist of well-documented studies of some small part of a larger system. The bits of research information can be absorbed directly by farmers in developed and developing societies. But many times farmers in less-developed countries cannot make use of this technology. The missing pieces of the research puzzle for a particular target area can be identified and studied by cropping systems research. Further testing and complementary research provides the appropriate technology for use through production programs and horizontal transfer of technology. Comparisons of Fig. 1 and Fig. 3 illustrate how research time and effort can be saved by transfer of appropriate technology from one target area, horizontally, to another.

Figure 2. This is a schematic representation of the research-extension workload distribution and interaction with farmers and other government agencies in different phases of cropping systems research and implementation.

Research-Extension interface over different phases of a cropping systems program

| | RESEARCH & IMPLEMENTATION PHASES | | | | | |
|---|---|---|---|---|---|---|
| Target Area Selection | I<br>Site Description | II<br>Econ & Biol. Pot'l | III<br>Design & Test | IV<br>Pilot Prod. Prog. | V<br>Implementation | Technology Transfer |
| | | | | | | |
| CSWG[1] | CSWG | CSWG | CSWG | CSWG | CSWG | CSWG |
| | | | | Extension<br>Farmer<br>Dir. Prod.<br>Local Gov't. | Extension<br>Farmer<br>Nat'l Prod.<br>Prog.<br>Local Gov't. | |
| Extension<br>Local Gov't. | | | Extension<br>Farmer<br>Local Gov't. | | | Extension<br>Other Nat'l<br>Gov't. Agen. |
| | | Extension<br>Farmer<br>Local Gov't.<br>Bureau Stat. | | | | |
| | Extension<br>Local Gov't. | | | | | |
| | | | | | | |

[1]CSWG – abbreviation for cropping systems working group which is the multi-disciplinary research group that coordinates and carries out the research plans of cropping systems programs in a target area.

Figure 3. Time frame for research and implementation phases of a cropping systems program with significant inflow of technology from research in areas with similar site descriptions. This technology transfer may reduce the research time in a target area by two or more years.

CROPPING SYSTEMS RESEARCH PROGRAM FOR SELECTED TARGET AREAS

PHASES

| Socio-economic Research | I | Biological Research |
|---|---|---|
| Agro-economic profile<br>Site reconnaissance | Site selection and Description<br>(initial) | Soil Classification<br>Climate<br>Water availability |
| | II | |
| Economic data collection<br>Technology Transfer IN<br>and evaluation | Economic and Biological<br>(yrs. 1-2) | Component Technology<br>Technology Transfer IN<br>retrieval and studies |
| | III | |
| Economic analysis of<br>Technology Transfer IN<br>patterns | Design and test cropping<br>patterns<br>(yrs. 1-2) | Partition target area<br>Technology Transfer IN<br>Reassign and test Patterns |
| | IV | |
| Socio-economic evaluation<br>Technology Transfer IN<br>technology and institutions | Pilot Production<br>Programs<br>(yrs. 2-3) | Identification of<br>Technology Transfer IN<br>Production Problems |
| Agricultural statistics | Implementation and<br>Technology Transfer OUT | Extension feedback |

## REFERENCES


Benchmark Soils Project. 1978. Research on agrotechnology transfers in the tropics based on soil family. Progress Report 1. Department of Agronomy and Soil Science. College of Tropical Agriculture, University of Hawaii, Honolulu. 64 p.

Biro Pusat Statistik. 1974. Statistical Pocketbook of Indonesia, 1972/1973. Published by Biro Pusat Statistik, Jakarta. 460 pp.

Inu Gandana Ismail and others. Cropping systems research in transmigration areas-Southern Sumatera (1977-1978). Cooperation work between the Directorate General of Transmigration and Central Research Institute for Agriculture. Bogor, Indonesia. 112 p.

McIntosh, J.L., Suryatna Effendi and A. Syarifuddin Karama. 1977. Testing cropping patterns for upland conditions. In: Proceedings, Symposium on Cropping Systems Research and Development for the Asian Rice Farmer, 21-24 September 1976. The International Rice Research Institute, Los Baños, Philippines, pp. 201-220.

McIntosh, J.L. and Suryatna Effendi. 1978. Soil fertility implications of cropping patterns and practices for cassava. In: Proceedings, IDRC workshop for intercropping with cassava. Trivandrum, India. November 27 - December 1, 1978. 29 p.

Muljadi, D. 1977. Sumberdaya tanah kering, penyebaran dan potensinya untuk kemungkinan budidaya pertanian. Kongres Agronomi.

North Carolina University. 1976. Agronomic-economic research on tropical soils. Annual Report for 1974, contract AID/CSD 2806. Raleigh, NC, USA. 230 pp.

# TESTS ON FARMERS' FIELDS: THE ICARDA EXPERIENCE

David Nygaard
ICARDA

## Introduction

Research on farmers' fields appears to be one area where a young center like ICARDA can contribute to the development of a methodology for farming systems research. The current attention given by agricultural development projects to on-farm trials has a short history, and there is an apparent potential to improve the way these trials are conducted. Indeed, there is a potential for reconsidering the role of on-farm trials in farming systems research (FSR). In this paper, this role is discussed in relation to ICARDA's experience: emphasis is given to the unusual composition of our Farming Systems Program and to the problems we have encountered working on farmers' fields.

FSR efforts tend to beg the question "So what's new?" This question is asked because FSR has been promoted as something very new and different when, in fact, it is only rearranging the environment in which research is conducted. It is a synthesis of traditional agricultural research activities. Independent discipline oriented projects are often less successful than they could be because they do not consider the interrelations between the many components involved. FSR specifically concentrates on these relationships, and there are now several examples which show the benefits for doing so.

Linking the disciplines through the four stages of FSR (a la Norman) [1] has helped unite the Farming Systems Program at ICARDA. The diagnostic stage has been well developed at, among other places, CIMMYT and IRRI; thus, there is no need to develop our own methods for research at this stage. Rather the Farming Systems Program (FSP) has carefully selected from the methodologies developed elsewhere and quickly moved to research at the design stage. Again, the Program has been able to choose from agricultural technologies employed in other regions of the world and has refined them and adapted them to circumstances in the Middle East. Although ICARDA is only five years old, we have already been able to test research findings on farmers' fields.

Barley production in Syria is an example which nicely illustrates this process. It provides the central thrust of this paper. The presentation is divided into three sections. In the first, research at ICARDA is briefly discussed to clarify the setting of FSR. In the second section, the findings of research on barley production in the diagnostic and design stages are presented to give a perspective to the research on farmers' fields and to explain how factors being tested in these trials were chosen. Then, in the third section, the results of the on-farm trials, the problems and special issues we have faced and the lessons that can be drawn from this experience are discussed. Barley production in Syria is an interesting example; although we are still a step away from successful on-farm trials, we are also close to making recommendations to farmers. The lessons from this exercise are clear -- the prospects exciting.

---

[1] Norman, D.W. "The Farming Systems Approach: Relevancy for the Small Farmer." MSU Rural Development Paper, No. 5, Michigan, 1980.

## Research at ICARDA

ICARDA was founded in 1977 and is one of the new centers sponsored by the Consultative Group on International Agricultural Research (CGIAR). The headquarters of ICARDA and the major research stations are located near Aleppo, Syria. The geographical focus of the Center is on rainfed agriculture in the Middle East and North Africa. In this area, the climate is characterized by cold, wet winters and hot, dry summers; the Center is concerned with areas where the average annual precipitation is between 200 to 600 mm. The Center was set up to have a systems orientation and also conduct major research on barley, faba beans, lentils and forages. Research on wheat and chickpea is done in collaboration with CIMMYT and ICRISAT respectively. Thus, the commodity research is conducted by three Programs, the Cereal Improvement Program, the Food Legume Improvement Program and the Pasture and Forage Improvement Program, and the Farming Systems Program is concerned with the role these crops play in the predominant systems in the region.

Early in the development of the Center, the FSP lacked focus. It tended to be the catch-all for research activities that did not fit in the commodity research programs. Consequently, the Program has scientists from a large number of disciplines. While initially this made it difficult to develop a coordinated research effort, one of the strengths of the Program today is a balance of research specializations.[2] This manifests itself in three ways. First, the Program has the capability to deal with a broad range of problems that constrain agricultural development in the region. Second, the strong representation of biological scientists and the high quality of their work has made the research more acceptable within the Center and within the region; this technical research has given the Program a degree of respectability vis-à-vis other biological scientists. This may not have been the case if the social scientists were the dominant group in the team. Yet, and this is the third point, the social scientists also have a clear role to play and their input is an integral part of the research. The team recognizes the importance of both agro-climatic and socio-economic constraints to development.

Currently, the FSP is involved in five research projects, each focusing on a problem area and each requiring a multidisciplinary team. One of these problem areas is the low productivity of barley production in the region, particularly where average annual rainfall is between 200-350 mm. Research on barley is discussed in the next section to illustrate the approach we are using at ICARDA and to introduce the research being conducted on farmers' fields.

## Barley Production in Syria

The importance of barley in the rainfed areas of the Middle East is well known. It is an important crop in an important sector as indicated by the proportion of cereal land allocated to barley (25 percent), its use as a major feed for animals (both as grain and forage), in some locations its use as human food, and as an important source of stability to agricultural systems in areas characterized by low and variable rainfall. However, the methods by which we can improve the productivity of this crop, and thus agricultural systems, are not clear.

---

[2]These disciplines should be noted and the scientists recognized as the results presented in this paper are theirs: A. Allan, (Agronomist), P. Cooper (Soil Physicist), K. Harmsen (Soil Chemist), D. Keatinge (Crop Physiologist), S. Kukula (Weed Scientist), T. Nordblom (Agricultural Economist), K. Somel (Economist), J. Stephens (Microbiologist), and E. Thompson (Livestock Specialist).

Stage I

The Farming Systems Program appropriately began its work on barley with a heavy emphasis on the diagnostic stage. Six villages in Aleppo Province in Syria were visited regularly and frequently for three years (1977/78 to 1979/80) in an effort to understand what farmers were doing and why. These six villages were selected along a s steep rainfall gradient in the province where average annual rainfall varies from more than 500 mm/year to less than 250 mm/year.

While the study did not concentrate only on barley production, a wealth of information related to barley emerged. The following findings guided the development of priorities for the agronomic research on this crop:

1. Barley increases in economic importance as one moves down the rainfall transect toward drier areas, but family income levels decrease. This has very important implications for ICARDA's research strategy. Since we are concerned with assisting the poorer farmers in the region, this leads us to barley production, particularly in drier areas.

2. Farm size is larger in drier areas as is the size of barley plots. To a large degree, mechanization of barley production has already been achieved in these areas. Yet, little use is made of chemical inputs, such as nitrogen and phosphorous fertilizers or herbicides for weed control. Few barley fields are planted with a seed drill and the seed rate appears to be surprisingly high. In addition, new varieties of barley have not yet been adopted by farmers.

3. Barley is a dual-purpose crop, i.e., it is grazed by animals as fodder and/or left to produce grain. As we traverse the transect towards drier villages, animal numbers per family increase and the percentage of the family income derived from sheep production becomes more important. The livestock component may also add stability to the family income stream. In dry years, barley is more important since feed prices are higher, and also animals provide a potential source of cash as they can be sold during the dry period. Certainly, livestock production very much complements the cropping activities of farmers in these dry areas.

It is now generally felt by members of the Program that the study which took three years was too long and that this phase should only need 6 to 12 months to produce initial results. However, this detailed and extensive information provided an invaluable basis for planning and initiating research on soil, water and nutrients in 1979/80.

While the village studies provided information on which research at the design stage could begin, the diagnostic stage should be, and at ICARDA is, an on-going process. Two surveys have been completed recently, one on sheep husbandry in the dry areas and a second on barley production throughout the country. The sheep survey has provided important information on the seasonal feed requirements of the animals in relation to the seasonal availability of feedstuffs.[3] To meet the needs of the sheep, barley is sometimes grazed during the growing season (1) at an early growth stage (and then it is left to recover for grain production) and (2) at harvest time in situ (when its value as a forage

---

[3]Thomson, E.F. and Bahhady, F."Further Aspects of Sheep Husbandry Systems in Aleppo Province, Syria." Research Report (Forthcoming).

exceeds its value as a grain). Nordblom has shown the strikingly important value of barley straw in proportion to grain.[4] Under a number of climatic conditions the straw contributes over half of the value of the crop: straw is a joint-product of barley production rather than only a by-product.

Somel has observed that different factors affect barley production in different areas of the country.[5] In the Northeast of Syria, land tenure, the recent but extensive use of machinery, and the annual migration of sheep flocks affect substantially the economic incentives to barley producers. In the West, a barley/fallow rotation predominates (compared to continuous barley in the Northeast). Mechanization is less common in the West, but the use of chemical fertilizers is higher. Finally, the agro-climatic zones in the western part of Syria are narrower and consequently inter-zonal effects, such as labor migration, are more predominant. Farmers in the drier areas are strongly and perhaps negatively influenced by the proximity of more wealthy farmers in the wetter areas.

Stage II

As in the diagnostic survey work, the experimental work on barley was conducted across the rainfall gradient. Within a radius of 80 km of Aleppo, five sites along this gradient were chosen for the experimental research. The sites and their average rainfalls are: Jindiress, 540 mm; Kafr Antoon, 459 mm; Tel Hadya, 350 mm; Breda, 250 mm; Khanasser, 200 mm.

The main emphasis of this research is a multifactorial agronomic experiment conducted at the five sites. The factors tested were seeding rates, the application of phosphorous and nitrogen fertilizers and the method of planting. Allan found the response to phosphorous to be particularly outstanding at the two drier sites.[6] This is shown in Table 1 where yields of both grain and straw are given for two years (1979/80 and 1980/81). Due to the significant response of the crop to fertilizer application, the team has focused on studying that relationship.

To illustrate the contributions of the various disciplines in the Program to understanding the effect of this fertilizer response and exploring its potential use by farmers in these areas, five points can be made: [7]

1. In physiological studies, Keatinge found that improved nutrition (particularly phosphorous) increased leaf growth and dry matter of the barley plant at a very early stage and that this advantage persisted until maturity. This resulted in 30 percent more tillers 45 percent more grains, and 24 percent more yield per ha. (Figure 1)

2. From current soil moisture studies, the soil moisture recharge and discharge patterns were derived (Figure 2). Crop moisture use and water use efficiencies calculated by Cooper show that where the barley crop was fertilized, it used more moisture more efficiently than an unfertilized analogue (Table 2).

---

[4] Nordblom, T.L. "Livestock-Crop Interaction: The Decision to Harvest or Graze Immature Grain Crops. "Discussion Paper, ICARDA.

[5] Somel, K. "Barley Production in Syria." Discussion Paper, ICARDA (Forthcoming).

[6] Allan, A. In various Research Reports of the FSP.

[7] These points are reported in detail in "FSP: Highlights of Research Activities, 1980/81 and Research Projects 1981/82." ICARDA, 1982, p. 41-49.

Table 1. Predicted yield parameters for low, medium and high rates of phosphate on Beecher Barley.[a] (in tons/ha.)

| | | 1979/80[b] | | 1980/81[c] | |
|---|---|---|---|---|---|
| | | Grain | Straw | Grain | Straw |
| | L | 3.26 | 4.17 | 3.28 | 4.56 |
| Jindiress | M | 3.26 | 4.17 | 3.83 | 5.33 |
| | H | na | na | 3.89 | 5.90 |
| | L | 3.49 | 4.33 | 4.26 | 7.01 |
| Kafr Antoon | M | 3.81 | 4.97 | 4.37 | 6.90 |
| | H | na | na | 4.89 | 6.38 |
| | L | 3.78 | 5.11 | 3.61 | 6.02 |
| Tel Hadya | M | 4.02 | 6.45 | 3.61 | 5.36 |
| | H | na | na | 3.61 | 7.39 |
| | L | 2.04 | 2.61 | 1.47 | 2 34 |
| Breda | M | 2.36 | 3.25 | 2.40 | 5.34 |
| | H | na | na | 2.50 | 5.25 |
| | L | 1.94 | 2.30 | 0.96 | 1.15 |
| Khanasser | M | 2.78 | 2.94 | 1.71 | 2.34 |
| | H | na | na | 1.85 | 2.59 |

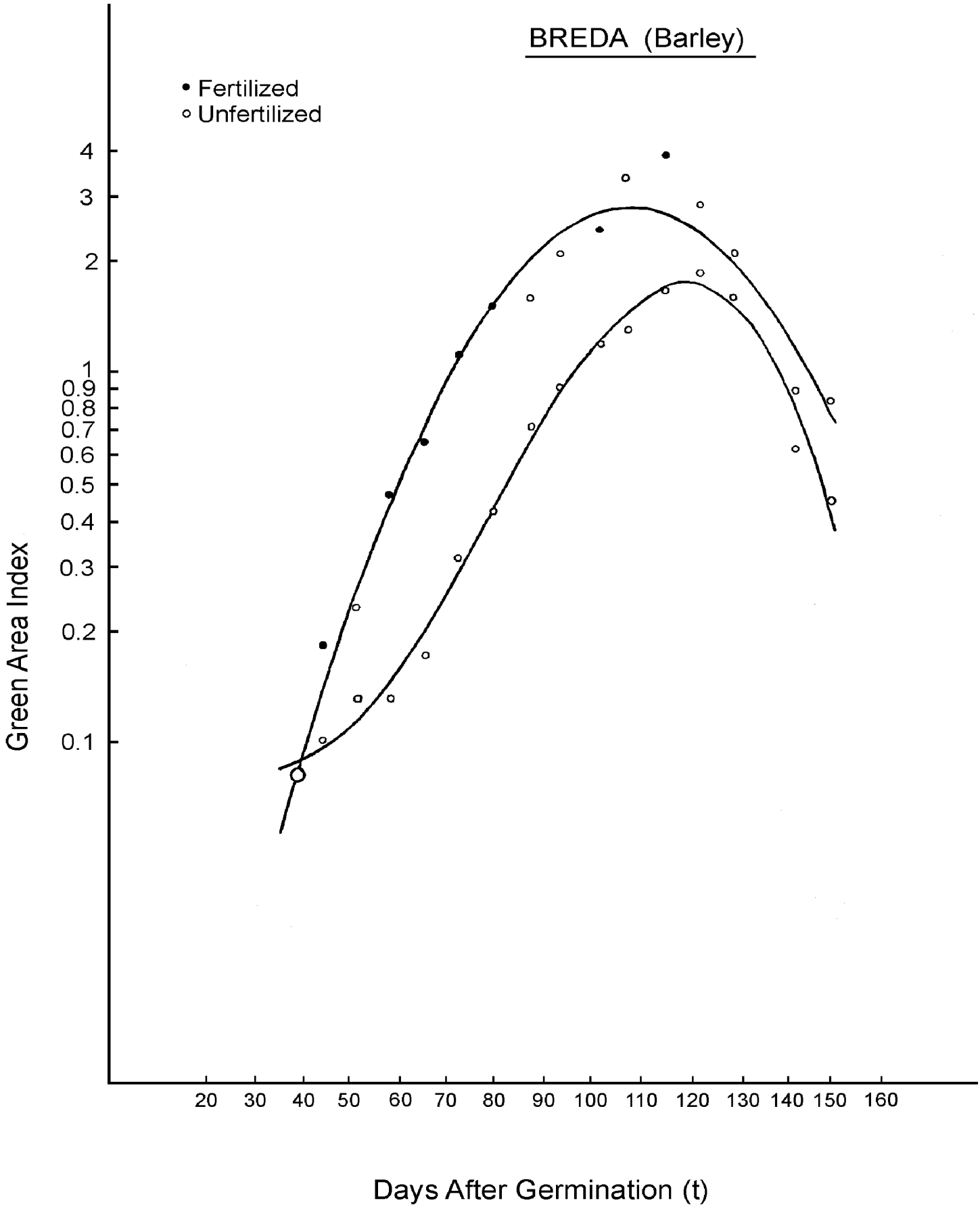
[a]Low = O $P_2O_5$ /ha, medium = 60 kg $P_2O_5$ /ha, and high = 120 kg $P_2O_5$ /ha.
na = not available in the first year.
[b]The 40 kg N/ha plots received a seed rate of 120 kg/ha.
[c]The plots received 60 kg N/ha at a seed rate of 90 kg/ha.

3. Harmsen determined the phosphorous contents for soils at the five sites (Figure 3), and these correspond quite well with the phosphorous response in the agronomy trials. For example, it explains why there was no response to phosphate application at Tel Hadya (Table 1 and Figure 3) where available phosphorous was high.

4. This research has clearly defined the gap in various rainfall zones between the potential yields on farmers' fields and the yields farmers are actually achieving. The FSP has taken samples from barley fields in each zone (Table 3, column 2), and yields of the FSP trials just described are also given (column 3). Note that the potential increase in grain production is greater in the drier sites and is an incredible 254 percent in the driest rainfall zone (200 to 250 mm precipitation per annum).

   This information reinforces our commitment to the dry areas in ICARDA region. These agronomic results, the findings of the surveys and the experience of our, scientists suggest that these drier areas (average annual rainfall not aver 350 mm) (1) at present are significantly more economically disadvantaged, (2) have been neglected by agricultural research projects in the past, and (3) somewhat surprisingly have a great potential for improvement, perhaps more so on a percentage basis than in the higher rainfall areas.

FIGURE 1


BREDA (Barley)
• Fertilized
○ Unfertilized
Green Area Index
4
3
2
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Days After Germination (t)

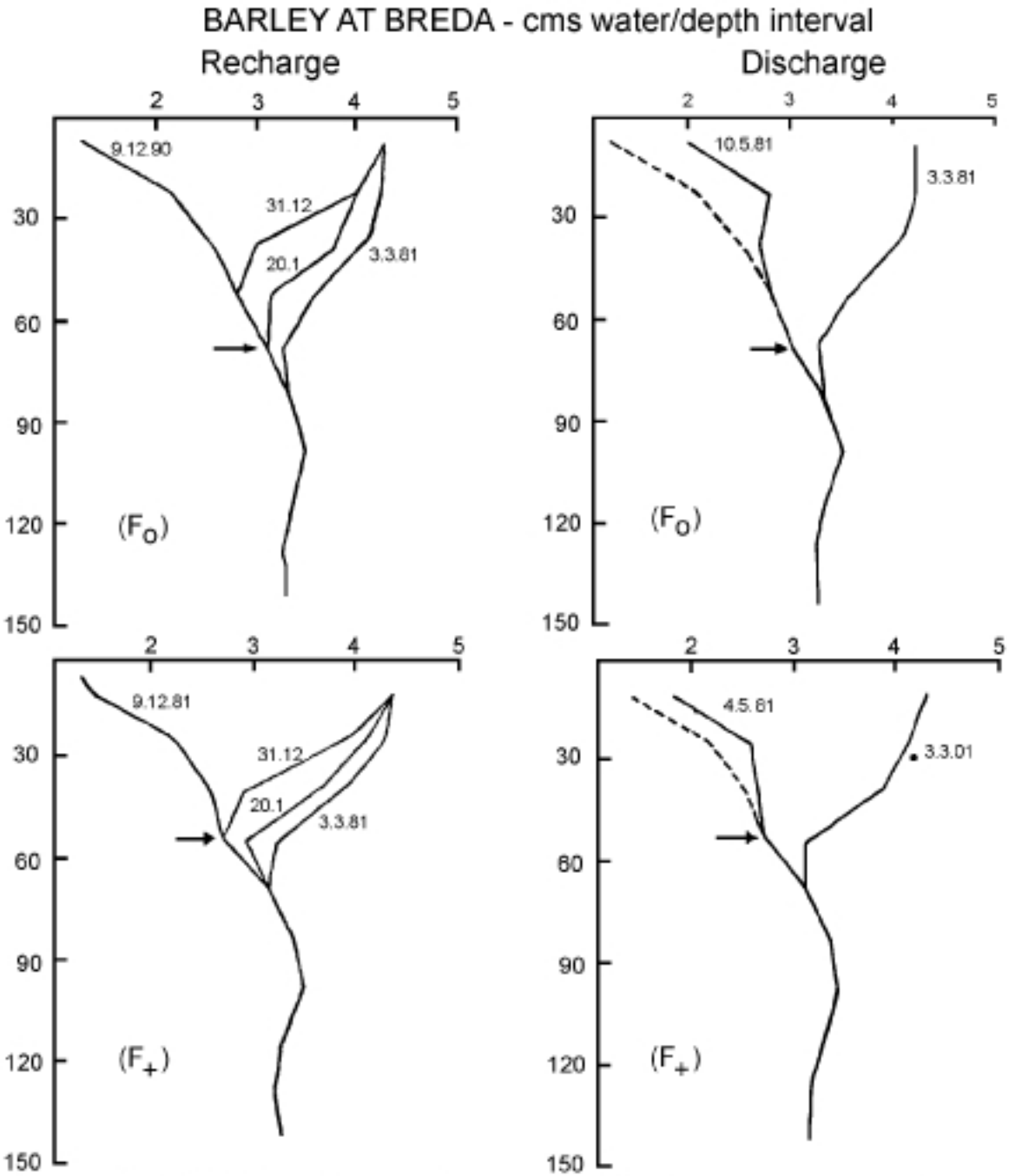



Fig. 2 Soil moisture recharge and discharge patterns under barley at Breda in the presence (F+) and absence (F0) of nitrogen and phosphorus fertilizer, 1980/81.

FIGURE 3. P- AVAILABILITY AT DIFFERENT SOIL DEPTHS

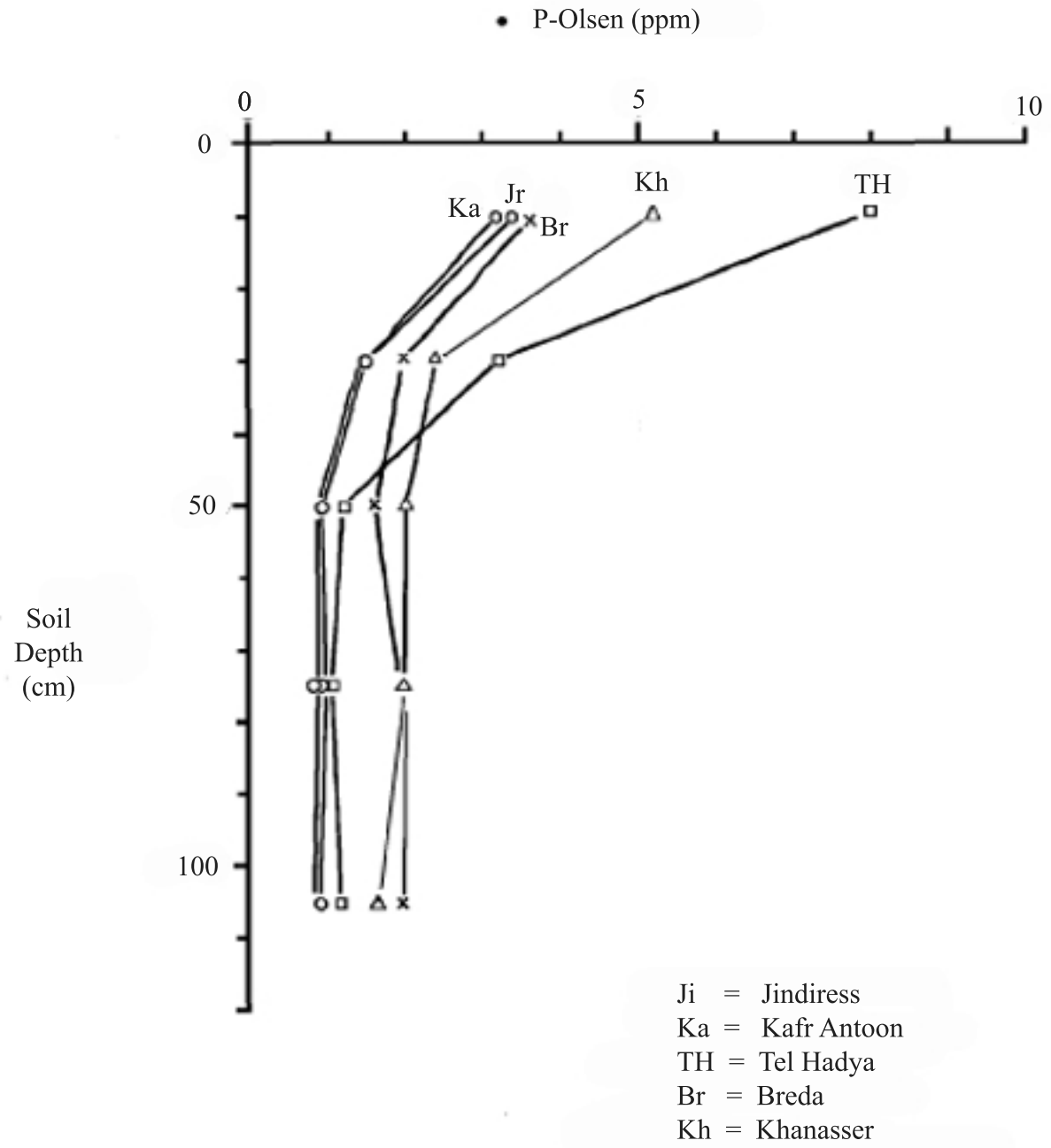


Table 2. Water Use, Dry Matter Production and Water Use Efficiencies for Barley (B) in the Presence (+) and Absence (-) of Nitrogen and Phosphorous Fertilizer

| TREATMENT | BREDA | |
|---|---|---|
| | $B_0$ | $B_+$ |
| Evapotranspiration (mm) | | |
| Germ. Anthesis | 193 | 181 |
| Anthesis Harvest | 57 | 67 |
| TOTAL | 250 | 248 |
| Dry Matter Production (kg/ha) | | |
| Anthesis | 1980 | 3847 |
| Harvest | 3550 | 4940 |
| Grain Yield | 1720 | 2130 |
| Water Use Efficiency kg/ha/mm | | |
| Germ. Anthesis | 15.4 (59)* | 21.3 (107)* |
| Anthesis Harvest | 10.0 | 16.3 |
| Total Period | 14.2 | 19.9 |
| Grain Yield | 6.9 | 8.6 |

*Figures in parentheses are units of "green area indices x days duration" for the period of germination to anthesis.

5. The causes of this gap need to be identified, and we are focusing our efforts on doing so. It is certain that part of the gap is due to economic conditions and cannot be closed. For example, the extra grain returned by the last few kilograms of phosphate may not pay for the increased costs. By constructing partial budgets (Table 4), we can compare two practices. In column 1, the revenue from the production of Beecher Barley with no phosphate (with 60 kg N/ha, seeding at a rate of 90 kg/ha and averaged over drilled and broadcast plots) is shown. In column 2 the calculation is given for the plots where 60 kg/ha pf $P_2O_5$ was added.

   There was an increase in production costs of 326 Syrian Lira when phosphorous was used. This includes the cost of the phosphorous itself, the labor to broadcast it, the cost to the farmer if he had to borrow money to buy the fertilizer and, no less important, the increased harvesting costs incurred to process the higher yields. Increased weed problems from phosphorous use have not been measured and this is not added to the cost calculations, but neither is the residual value of phosphorous to a subsequent crop in the same field added to revenues. As can be seen by comparing the net benefit of these two practices, 60 kg of $P_2O_5$ is highly economic, as net revenue increased by 925 Syrian Lira. This gave a benefit cost ration of 2.8 or every extra Lira spent returned 2.8 lira: increased use of phosphorous fertilizer is an attractive option indeed.

Table 3. Barley yields 1980/81.

| Rainfall[1] Zone | Yields on Farmers' Fields | Yields on FSP Trials | Potential Increase (in percent) |
|---|---|---|---|
| 1 | 3,150 | 4,100 | 30 |
| 2 | 1,211 | 3,610 | 198 |
| 3 | 1,106 | 2,400 | 117 |
| 4 | 674 | 1,710 | 254 |

[1]Agricultural areas in Syria can be divided into four agricultural stability zones which are most strongly influenced by average rainfall. They are:

Zone 1 Over 350 mm of rain per year.
Zone 2 250-350 mm and not less than 250 in two of three related years.
Zone 3 Over 250 and not less than this in half the years.
Zone 4 200-250 mm and not less than 200 in half the years.

Table 4. Partial Budget for Phosphate Application to Barley at BREDA (Rainfall 292 mm in 1980/81 Cropping Season)

Figures per ha

| | No $P_2O_5$ | 60 kg $P_2O_5$ |
|---|---|---|
| INCOME | | |
| Grain Yield | tons 1.470 | tons 2.400 |
| Grain Revenue | 1,029. SL | 1,680. SL |
| Straw Yield | tons 2.340 | tons 5.340 |
| Straw Revenue | 468. SL | 1,068. SL |
| TOTAL REVENUE | 1,497. SL | 2,786. SL |
| EXPENSES | | |
| Fertilizer | | |
| $P_2O_5$ x price | - | 130 SL |
| Labor for application | - | 10 SL |
| Credit | - | 13 SL |
| Harvesting | | |
| Labor, equipment, transport, bags, etc. | - | 173 SL |
| TOTAL CHANGE IN EXPENSE | 0 | 326 SL |
| NET BENEFIT | 1,497. SL | 2,422 SL |

Notes: a) Cost of $P_2O_5$ = 2.17 SL per kg
b) Price of Barley grain = 0.70 SL per kg
c) Price of Barley straw = 0.20 SL per kg
d) Labor for Broadcasting = 10.00 SL per 120 kg of TSP fertilizer
2) Both trials received 60 kg of N, at a seed rate of 90 kg with Beecher barley.

The agronomic experimentation continued in 1981/82 season. The climatic conditions were quite unusual this year with an abnormally cold winter and less average rainfall early in the season. The results of the trials were never-the-less consistent with what we had found before; the response to phosphorous application was significant. Thus, we have three growing seasons, each different, in which the results have been similar. It was after the second year, however, that we made the choice of factors for on-farm trials. That research is discussed in the next section.

Test on Farmers' Fields

Stage III [8]

One characteristic of on-farm tests is that they are still research and not demonstrations; thus, while two years of agronomic work is not sufficient to develop recommendations for farmers, it is sufficient to move to the testing stage with some major findings. As variety and phosphorous were thought to be likely changes that could improve barley production in these areas, tests were set up to evaluate the effect of these two factors on barley production when they are grown under the farmers' conditions. The objectives of the trial were to: (1) measure and compare the yield of local Arabi Aswad (Black Arabic) versus the improved variety, Beecher, (2) compare the response of both varieties to phosphorous application, (3) evaluate the economic return from these changes and (4) determine if there are any constraints to prevent farmers from adopting these practices if they were recommended.

The experiments were carried out in two villages, Breda and Khanasser in the drier zones. The design and lay-out of the experiments were kept simple. In each village, four sites of 0.4 hectares each were selected. Since this type of trial does not lend itself to or require statistical analysis, the trial is not replicated at each site.[9] Instead, it is more useful and informative to repeat the experiment at different sites with different farmers in the same agro-climatic zone.

The trial site is divided into four plots to accommodate the following treatments:

Plot 1. Arabi Aswad barley with other inputs controlled by the farmer according to his normal practices,
Plot 2. Arabi Aswad barley plus 50 kg/ha of $P_2O_5$ with farmer's practices,
Plot 3. Beecher barley with farmer's practices,
Plot 4. Beecher barley plus 50 kg/ha of $P_2O_5$ with farmer's practices.

The non-test factors were held at the farmers' levels. ICARDA provided the new inputs while the farmers provided the land and other materials and contributed their own labor and management.

At Breda, farmers normally sow their seeds after the first rain in early November. They cultivate the land once (ayar) and cover the seeds (rdad) by duckfoot cultivator. Both seeds and fertilizer are broadcast. At Khanasser,

---

[8]The contribution of F.Asfary, H. Halimaeh and M. Hallajian to this section are gratefully acknowledged.

[9]Accepting the lack of control and statistical precision can be frustrating to scientists who have been trained to conduct their research on experiment stations.

the lower rainfall site, farmers sow their seeds as early as September before the beginning of the rainfall season. They cultivate the land once (ayar) by a duckfoot cultivator and cover (rdad) the seeds by either drawing a bar across the plot (tabban) or a duckfoot cultivator. Seeds are generally broadcast, but some farmers may drill the seeds after leveling the soil with a tabban. In both zones, farmers use a similar seeding rate of 125 kg/ha. Although this rate is high, the same rates were used in the trial in order to keep with local practice: the seed rate was not a test factor.

Results from six of the trials are reported in Table 5, three experiments (1, 3 and 4) at Breda and three (5, 6 and 7) at Khanasser. The other two experiments (one each at Breda and Khanasser) are excluded as these experiments were grazed by sheep. The yields of Beecher and Arabi Aswad were both relatively low. This is partly attributed to the unusual frosts which occurred intermittently during a long period between November and April (40 days at Breda and 47 days at Khanasser). Also, yields of Arabi Aswad were unexpectedly close to those of Beecher. Beecher Barley had better growth than Arabi Aswad early in the season, but this is not indicated in the yields; Beecher Barley may have been more damaged by the frost than Arabi Aswad. At least Beecher did not recover as well, and late in the season when moisture was limiting, Arabi Aswad seemed to catch up. In general the effect of variety and phosphorous application on grain and straw yield varied greatly, and little can be said about the impact of either factor.

These results are disappointing but extremely informative, and the lessons learned from the exercise are valuable if they can be incorporated into future research. The farmers themselves were excellent sources of information to explain the differences between the sceintist controlled trials and those of the farmers. During the growing season, the farmers were visited frequently by the team, and information was gathered from them about their production practices and about the importance of barley to their family income. These visits provided a means for the farmer to become more involved in the research and for us to see the farm family's reactions to the trials and determine what problems (technical or otherwise) he would have in adopting any recommendations that may come out of this research. Some of the information collected during these visits is summarized in Tables 6 and 7.

Relevant points that were raised by farmers in these interviews are:

1. The history of each plot was recorded, and in retrospect we did not pay enough attention to this issue when the plots were selected. Most of the plots were sown with barley last year (1980/81) and this may have strongly influenced the results; the experimental results reported in the previous section were on plots that were fallow in the previous season. In addition, other research in the FSP shows that continuous barley quickly leads to low yields. Farmers know a barley/barley rotation leads to low yields, but they argue that they do not have enough land to leave any of it fallow. Thus, at the experimental level alternatives to barley/fallow are being studied, but this season we are conducting the on-farm tests in the fallow/barley rotational sequence.

2. There was a confusion between Beecher Barley and a similar variety (same color) grown in this area about six years ago. The variety was discarded because of its poor feed quality. When Beecher is released by the Syrian Government, an extension effort must be conducted to assure that this confusion does not occur.

Table 5. Grain and straw yields (kg/ha) of barley at Breda and Khanasser 1981/82.

| | | Arabi Aswad-P | | Arabi Aswad+P | | Beecher-P | | Beecher+P | |
|---|---|---|---|---|---|---|---|---|---|
| Zone | Trial No. | Grain | Straw | Grain | Straw | Grain | Straw | Grain | Straw |
| 3 | 1 | 774.4 | 1191.3 | 646.7 | 714.7 | 508.1 | 671.4 | 973.3 | 975.2 |
| | 3 | 516.3 | 594.2 | 431.2 | 576.4 | 583.6 | 605 | 535.6 | 531.8 |
| | 4 | 796.2 | 1081.5 | 910.3 | 1236.4 | 595.1 | 967.4 | 799 | 1133.2 |
| | Mean | 695.7 | 955.7 | 662.7 | 809.2 | 562.3 | 748 | 769.3 | 880.1 |
| 4 | 5 | 46.3 | 222.2 | 216.7 | 298.1 | 159.3 | 442.6 | 163 | 309.3 |
| | 6 | 170.4 | 295.3 | 144.4 | 214.8 | 70.4 | 215.1 | 120.4 | 335.2 |
| | 7 | 830.5 | 969.6 | 972.7 | 1147.6 | 667.6 | 1268.8 | 771 | 1170 |
| | Mean | 349.1 | 483.5 | 444.6 | 553.5 | 299.1 | 642.2 | 351.5 | 604.8 |

Table 6. Information from farmers.

| Zone | Farmer | Farm Size (ha) | Last year's barley yield (kg/ha) | Animals Sheep & Goats | Plot History | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Soil | | | Previous Crop 1980/81 |
| | | | | | Quality | Depth | Topography | |
| 3 | 1 | 22.5 | 350 | 100 | Poor | Medium | Slight slope and stony | Fallow |
| | 2 | 10 | 1000 | 5 | Poor | Shallow | Stony | Barley |
| | 3 | 3 | 635 | 10 | Fair | Medium | Flat | Barley |
| | 4 | 16 | 900 | 6 | Good | Medium | Slight slope but no stones | Barley |
| 4 | 5 | 15.5 | 400 | 0 | Good | Deep | Flat | Barley |
| | 6 | 30 | 1500 | 0 | Medium to poor | Medium | Flat some stones | Fallow |
| | 7 | 20 | 1800 | 0 | Good | Deep | Flat | Barley |
| | 8 | 53 | 720 | 0 | Good | Deep | Flat | Barley |

3. But there may also be a problem with the feed quality of Beecher as the farmers complained about this. We found cases where the grazing value of a standing Beecher Barley crop was half the value of a field of Arabi Aswad. Farmers claimed that Beecher grain needs to be crushed before feeding it to sheep and that the straw is too tough. Digestibility studies of these two joint-products are currently being conducted at ICARDA.

4. There is a problem in these drier areas with the availability of fertilizer as it is difficult for the farmers to acquire phosphorous from the government distribution centers, particularly for use on barley. If a farmer has some irrigated areas, he can get fertilizer (and short-term credit if necessary) from the Agricultural Bank, but not for his barley plot. If he does not own irrigated land, he must buy fertilizer in the market at higher costs and frequently arrange for it to be transported from Aleppo. If fertilizer use is going to be recommended on these dry areas, we must involve the government organization responsible for fertilizer distribution in this research.

5. We found a peculiar distribution of animal ownership. Next year, more farmers that cooperate in the on-farm trial should own sheep. We know from other research that most farmers in rainfall zones 3 and 4 own animals, and that decisions with respect to barley production are strongly influenced by the feed requirements of the sheep. Since none of the farmers near Khanasser with whom we are cooperating owned animals, we received little information from them on the important interaction between livestock and crops. Those farmers who did have sheep raised several questions about grazing barley plots. These are currently under investigation by Bordblom in the study mentioned above.

6. The decision about grazing the barley plots is certainly important and complex. Since his year (1981/82) was a poorer growing season than normal, many farmers in the dry areas did not harvest the barley but left it for the sheep to graze. This raises an important question: How should we treat experimental plots that are grazed? Two of the on-farm trials were grazed this year, and this problem has been encountered frequently in research in the Cereals Improvement Program on farmers' fields. The tendency is to ignore these cases rather than use them to understand farmers’ practices and to estimate the profitability of grazing.

One can see from Tables 6 and 7 that additional lessons could be drawn from the information provided by farmers involved in this research. However, the description of the research and the six issues raised in the interviews should be sufficient to indicate the style of the work we are conducting on farmers' fields as well as its value to the FSR process.

From a personal perspective, I have been struck by the power of this research once the farmer becomes involved. This has become clear at a number of different levels.

First, the information provided by the farmers involved in the on-farm tests is more accurate and more detailed than the information generally collected at the diagnostic stage. This is natural; the confidence that developed with the

Table 7. Information from farmers about barley yields and prices.

| Farmer | Yields 1981/82[a] | | Price[d] of barley in spring | | Cost of[d] grazing barley | Cost of[d] grazing stubble | Cost of[d] hand harvest | Comments on Trials |
|---|---|---|---|---|---|---|---|---|
| | Grain on own field | Straw[b] on own field | Grain | Straw | | | | |
| 1 | 300[c] | 500 | 1.25 | .50 | 150 | 20 | 300 | Convinced of cultivar differences but not fertilizer effect |
| 2 | 700 | 3000 | 1.25 | .35 | 100 | 20 | Family labor | Accepts cultivar but wants more experience |
| 3 | Grazed[c] | Grazed | 1.15 | .40 | 80 | 20 | Grazed | Does not understand the trial. Not sufficient explanation |
| 4 | 1500 | 3000 | 1.10 | .50 | 100-300 | 20 | 300 | Likes new varieties |
| 5 | 250 | 380 | 1.10 | .80 | 120-150 | 25 | 250 | Could see cultivar and fertilizer effects early in season which disappeared by harvest time |
| 6 | Grazed | Grazed | 1.05 | .80 | 175 | 30 | Grazed | Offered suggestions on planting date and method. No differences in treatments |
| 7 | 750 | na | 1.05 | .80 | 225-250 | 30 | 350 | Was impressed with fertilizer response even in a poor year. He is confused about Nitrogen and Phosphorous fertilizers |
| 8 | Grazed | Grazed | 1.25 | 1.00 | 250 Arabi Aswad 125 Beecher | 25 | Grazed | Very concerned about grazing qua-Beecher |

[a]In Kg/ha.
[b]If hand harvested
[c]Hail at harvest affected the yields of farmers 1 and 3. Other farmers had harvested before this date.
[d]In Syrian Liras.

farmer as he got to know us better and his increased understanding of the research encouraged him to be more open. The accuracy of socio-economic variables are particularly important. Several questions which had been asked but poorly answered in surveys were answered much more completely by farmers cooperating in the on-farm tests. The pressure for continued use of the land and the problem of fertilizer availability are two examples of factors that were only brought to our attention at the testing stage. Thus, next year we plan to allocate even more time to such discussions with these farmers.

Secondly, the actual reporting of the information gathered in these visits has served to improve communication among team members. Theoretically, FSR calls for multidisciplinary teams to work together to solve the problem of the farming systems; all team members should participate in each phase. In practice, however, frequently only two or three team members are involved in these discussions. Thus we experimented, from a communication perspective, on giving rapid feed-back from these visits. Short, informal write-ups were circulated to team members within two to three days of the visit. They were written in a light manner to keep reader's attention and yet intended to be informative. Not only did these serve as an effective communication device within the SP, but they stimulated comments from other scientists as well (for example, from the Cereal Program where barley is an important research topic). An example of such a communication is reproduced in the annex.

FSR is often described as an interactive process, where new information is constantly evaluated by the research team and the team returns to previous stages of the FSP process to clarify points and gain further understanding of the agricultural process.[10] At ICARDA, information that has emerged from the on-farm trials has repeatedly sent us back to Stages I and II. For example, determining the magnitude of barley use as a forage has been a part of the barley survey, i.e., a return to the diagnostic stage. Observations that farmers have made about the palatability and digestibility of Beecher Barley has prompted investigations on these issues on sheep at the experiment station, i.e., a return to the design stage.

Finally, the successes and failures of ICARDA's experience in on-farm tests have shown us the applied and practical nature of FSR. We agree with others that a key to on-farm trials is to differentiate as to the degree of farmer involvement. Progressing from scientist managed to joint (farmer-scientist) managed and then to farmer managed trials is a necessary sequence in order that recommendations for farmers can be developed.[11] While ICARDA's research has not progressed past the stage of joint-managed trials, we already have seen the value of on-farm trials as a way to solve problems that would not have been faced if research were organized along traditional lines. As this example should illustrate, we are now close to recommending new technologies or new production practices with the confidence that they will be easily and quickly adopted by farmers for whom the research is intended. This assumes that issues of feed quality, fertilizer availability, etc., will be settled beforehand.

---

[10]Gilbert, E.G., D.W. Norman and F.W. Winch. "Farming Systems Research: A Critical Appraisal." MSU Rural Development Paper; No. 6. Michigan 1980, p. 17.

[11]Shaner, W.W., P.F. Philipp and W.R. Schmehl. Farming Systems Research and Development: Guidelines for Developing Countries. Colorado, 1981, p. 111.

Stage IV

The process of extending these results to farmers, once they have been verified, is likely to raise as many interesting and complex questions as were found in conducting on-farm trials. While ICARDA looks forward to interacting with national extension services and other organizations in the Middle East, we have not yet arrived at this stage. Others can contribute more to discussing this issue, and it is not dealt with in this paper.

Conclusion

In spite of the increased exposure that FSR has had in the past five years, few agricultural scientists, at least in the Middle East, have been exposed to it. FSR encompasses a wide variety of activities --perhaps too wide – and it is a bit nebulous.[12] However, it should be flexible and adaptable to the many and various agricultural systems in the world. If a few basic principles can act as common threads to hold the fabric of FSR together, the concept can prove to be useful even though there are differences in the approaches taken by its practitioners. Improving the methodology of on-farm trials is one area which would strengthen FSR, and, at ICARDA, we think we can contribute to this process. We will do so with a strong team of biological scientists and with an important stress on communication.

[12]Byerlee, D., L. Harrington and Donald L. Winkelmann. "Farming Systems Re- search: Issues in Research Strategy and Technology Design." Invited Paper AJAE meeting. Utah, 1982.

# ANNEX

## BARLEY ON-FARM TRIALS

### Interview with Farmer No. 4

#### Introduction

Fahed Hajdaher is one of the four Breda farmers who is cooperating with ICARDA in on-farm barley trials this year. He was initially contacted through the Breda Agricultural Office with the help of Saied Assa (Abou Ali), our guardian at the Breda experimental site. On February 3, neither rain, cold nor strong winds could dampen Mr. Fahed's enthusiasm to first show us the test plots on his field and then his willingness to patiently answer our many questions in his home. While having uncertain expectations for the trials, he is certain of one thing -- he wants to improve his barley yields.

There are four such cooperative farmers in Breda. Both Mr. Fahed and Mr.Saied (who was present during the interview) explained that some of the villagers were not willing to cooperate with ICARDA. The scars left from land reform changes in the past 20 years are still visible and the farmers possess some fear of losing their land. Mr. Fahed cooperated because he wants to develop an on-going relationship with knowledgeable scientists so that he can seek help with problems of worms or disease in the future. He also wants to learn about new techniques such as fertilizer application and new varieties.

He does expect yields on the trials to be higher than his own field, although he was hesitant to attribute this to either one of the two effects we are testing -- the application of phosphate fertilizer or Beecher, a new cultivar of barley. Yet, as a result of our trials, Mr. Fahed had increased phosphate use on his own barley plots. (More on this later.)

He expects the new cultivar to have longer stems. This is a useful characteristic since it makes mechanical harvesting easier. On the other hand, he was concerned about the quality of the Beecher grain. He gave us a long explanation of the differences between his barley (black) and our barley (white). He feels that black is superior to white as (1) animals like it better, (2) the price is higher (the current price of black is 1.1 SL/kg and white is 0.9 SL/kg; at harvest, black was 0.65-0.80 SL/kg) and (3) it has a higher potential yield (15 times the seeding rate). (Note the inconsistency with the above paragraph.)

These impressions are unfortunate since he is confusing Arabi Abiad (Arabic White) with Beecher. This is a misconception that we need to correct in the next several visits, and perhaps small signs on his plots in Arabic would help. Obviously, he has no information on which to base his expectations of Beecher's yield potential. (He has not visited the trials at the nearby FSP site in either of the previous two years.) The discussion led to his conclusion that (1) he had not tried this variety before, and he was waiting to see the yield, (2) it was not yet available in the Aleppo region, but (3) if it is good he would try to find it for his own use next year.

#### Special Topics

Our subsequent line of questioning revolved around three topics. They are straw (tiben) use and other feeds, barley production and barley yields and use. We discuss each of them in turn.

A. Straw Use

Mr. Fahed explained that white barley straw is important, and it is also expensive to gather after harvesting. Combine harvesting, which reduces the need for labor, yields a cost savings which more than pays for the loss in straw. On barley fields that are machine harvested, the majority in the village, the straw is not gathered, but the fields are grazed by sheep. If the farmer does not have enough of his own sheep, he may rent out the field for other flocks in the neighborhood. The rental price for this was 20 SL/ha last year, which seemed to us to be surprisingly low.

The flat village lands are almost all machine harvested, but there is a small stony hill area nearby which is still hand harvested and this is the source of barley straw for winter feed. This amounted to about 1-2 hectares for Mr. Fahed.

Straw is also used in constructing mud houses. Straw for this purpose does not need to be long, and shredded straw from the combine harvested plots can be used.

Mr. Fahed only has six head of sheep which supply milk and yogurt (laban) for the family. Thus, he does not graze all his barley land with his own sheep and he rents that which is extra, frequently to bedouin flocks.

He indicated his understanding of economics in defending his claim that barley straw has little economic value. We asked about yield increases in good years and thus more income from straw sales. He patiently explained that in good years there is also good grazing in the nearby steppe (badia) and demand for grazing harvested crop land declines as do straw prices. A poor year produces the converse effects so the actual earnings per unit land area are rather steady (and small).

Yet, in spite of this, he told us the white tiben (barley and wheat) currently costs about 0.40-0.50 SL/kg.

After his animals graze barley residues in the summer, they graze cotton crop residues in the autumn. These residues are more valuable where land rents reach 400-500 SL/hectare, i.e., 20 times barley crop residues. In the winter he buys feeds such as cotton seed hulls, cotton seed cake and wheat bran from the nearby government cooperative. He sometimes buys barley and straw either from the local market or from a neighboring village.

During the winter the sheep graze the village common lands and during the spring (March onwards) these lands supply a high portion of feed requirements. He stressed the need for the sheep to get exercise, which, among other things, keeps them healthy.

There is one flock in the village which is managed by a shepherd from the village, who is paid a monthly salary.

B. Barley Production

Mr. Fahed is growing 16 hectares of barley this year. Eleven hectares are his own and five hectares are from his brother who is paying off a debt to him for performing tractor services. The 11 hectares are on three soil types and are divided as follows:

1. Good soil (Type 1) 6 ha in 3 plots,

2. Medium soil (Type 2) 3 ha in 1 plot, and

3. Poor soil (Type 3) 2 ha in 2 plots.

We discussed in some detail the parcel which contained the trial (which is also his best one). It is five hectares. This is on flat land with good soil which is described as type 1 soil according to their classification of the land, and the two other types which are type 2 and 3 are recognized as average and poor or very stony soil. Consequently, each major soil type is managed in a slightly different way with regard to seed, fertilizer inputs, and the method of harvesting.

He has planted continuous barley on his soil type 1 plot for 14 years. Our disbelief showed, and he explained that this is possible since he uses chemical fertilizer. From 1974 to 1978 he used 40-60 kg/hectare of Triple Super Phosphate (48 percent). In 1978 he used some manure, and from 1978 to the present he has used a new kind of phosphate fertilizer and he was not sure of its strength. Later he showed us the bag and it was 45 percent $P_2O_5$ .

Land Preparation

Since this field is near the village, it is heavily grazed after the harvest. Thus, in August he makes two passes with a cultivator, the second pass at right angles to the first one. Every third year he uses a disc plow instead of a cultivator, as this makes a deeper cut.

Then he waits until the first rain. This year in early December, he cultivated once, broadcast his seed and made a second pass to cover the seed. An application of phosphate was also made at this time.

He remarked that in the past he has used a spinner to spread the seed. He seeded at a rate of 120-150 kg/ha; the average this year was about 130 kg/ha. The seed was from his own stock and not treated. (He only treats his wheat seed with H-CB.) However, the seed was selected from his best barley field last year.

This year he applied 100 kg of 45 percent phosphate/ha (45 kg $P_2O_5$/ha). Since we believe this is unusual for Breda, we may wish to inspect neighboring fields this spring to compare our test plots. Also the residual effects from last year's $P_2O_5$ application (40-50 kg/ha of 45 percent phosphate) may effect this year's non $P_2O_5$ plot. He does not use $P_2O_5$ from the agricultural bank in Aleppo. If one does not have irrigated land, chemical fertilizer cannot be bought from the bank. This year the phosphate cost 927 SL/ton (45 percent), not including transportation. Phosphate is available in the market (sook) at 1,300 SL/ton and 100 SL/ton for transportation and loading.

He does not use nitrogen on barley fields and is not sure of its value. He said that nitrogen is only used on irrigated plots in the village.

At this point, we stopped the discussion of the production practices because the season had not yet advanced to the stage of considering graze, weeding, etc. We switched the discussion to the four test plots that are on this same five hectare parcel. He spoke fondly of Messrs, Fares, Allan and Haitham. While it is not clear why he should like these three "provocateurs" of change, we should

give them high marks for the relationship that they have established. He mentioned that he had prepared the land for all four test trials and had refused any compensation. The only thing he would like from ICARDA would be a new pair of binoculars for hunting falcons this summer. We gladly leave this problem for the agronomists to work out.

Initially, it was not clear that he understood these various treatments on the plots. After some discussion, however, it became clear that he did. He noted, among other things, that the trials were planted 10-15 days earlier than the rest of the field and had almost germinated when he planted his field. At the present stage of plant growth, no differences could be observed among the four plots. With some prodding from us he decided that the variety effect will be bigger than the fertilizer effect. Why? "Because you have already put so much work into this variety to bring it way out here, it must be good."

It will be interesting, and necessary, to visit the trials several more times this year with Mr. Fahed to elicit his impressions as the plants develop and as, hopefully, some differences in treatments become apparent.

C. Yields

In a short discussion on yields, Mr. Fahed explained that yields depended on soil type. Last year's yields for various soil types were:

- Type 1 8-10 shwals/ha = 8-10 quintals
- Type 2 6 shwals/ha = 6 quintals
- Type 3 1- z shwals/ha = 1-4 quintals. He estimates one shwal to be about 100 kg of barley.

On the five hectare plot he received 8 shwals/ha or 800 kg/ha last year. These fields were harvested by a combine hired from a distant village. We would think that these yields are not too difficult to beat and it will be interesting to get Mr. Fahed's opinion when we do.

In very good years, the barley is grazed in February to prevent lodging later on. In poor years, it is possible that the fields will be grazed in April/May, instead of being harvested. However, according to Mr. Fahed, this is rare. The last time he did this was in 1969. He claimed that even in 1978/79, a dry year, he still harvested his fields.

Summary and Recommendations

At this stage, there are few changes that one could suggest since Mr. Fahed has responded very favorably to the many questions that we asked. He is very pleased with the cooperation so far and is closely following the progress on the trial plots. We would only suggest five issues for future consideration:

1. In order to inform the Breda farmers better about our work at the SWAN site, a farmer's day may be useful. We may as well publicize our research effort there.

2. We should keep an eye on the neighboring plots in order to measure the effect of Mr.Fahed's use of $P_2O_5$ on his plot compared to our non-$P_2O_5$ plots and compared to other non-fertilized plots.

3. We could easily mark the plot with signs in Arabic. This should help clarify the differences between "white" barley and Beecher.

4. We may also want to look at the palatability of Beecher straw. This should go hand-in-hand with other work in the Center on dual-purpose barley.

5. We need to assess, in the next several visits, the effect of planting earlier than the farmer and the effect that this may have on weed population.

Mr. Fahed is certainly a pleasant, talkative and articulate person. Undoubtedly, he is one of the leaders in the village. It is interesting to note that Breda does not have a leader (mukhtar) at present. Apparently, Mr. Fahed's father was the (mukhtar) at an earlier date and it may be that Mr. Fahed fills some of the roles of a village leader. This will become clearer when we visit the other three cooperating farmers.

# INSTITUTIONAL INNOVATIONS IN NATIONAL AGRICULTURAL RESEARCH: ON-FARM RESEARCH WITHIN IDIAP, PANAMA

Juan Carlos Martinez
Regional Economist
CIMMYT's Regional Economics Program for
Central America and the Caribbean

and

Jose Roman Arauz
Agronomist
Regional Research Coordinator
Instituto de Investigación Agropecuaria de Panamá (IDIAP)
Chiriqui, Panamá

## I. THE NATIONAL FRAMEWORK AND THE INSTITUTIONAL ORGANIZATION OF IDIAP

Panama has characteristics which distinguish the country from the rest of Central America. First, the effect of the Panama Canal on the economy has led to the development of an important financial and commercial sector geared toward international trade; this is reflected in the relative importance of the services sector within the country's gross national product (about 65%). Second, Panama's rich natural resources, in relation to its population of some two million, and its ecological diversity offer the potential for self-sufficiency in food production.

The agricultural policy of the government during the past decade is a clear indication of its intention to increase domestic production of basic grains to satisfy the rising per capita level of consumption of the growing population. In particular, the government's pricing policy has stimulated domestic grain production for import substitution. In the early 1970s, relative prices of basic grains increased as a result of a sustained program of government guaranteed prices. In addition, the programs of MIDA, BDA, and IMA[1] were broadened and geared toward production and income-redistribution objectives.

Until 1975, agricultural research had been carried out by the Ministry of Agricultural Development (MIDA), the University of Panama, and various public and private institutions. Then the Agricultural Research Institute of Panama (IDIAP) was created for the purpose of consolidating research forces to effectively reach Panama's farmers; research scientists from MIDA formed its nucleus.

A guideline of the institution was that of focusing research on specific regions and crops for the development of technologies appropriate to representative farmers in areas defined as high national priorities. Research could thus be concentrated on the most important farmer problems and on the scarce resources of IDIAP used to the best advantage. Its activities were planned in a sequential pattern to permit methodological adjustments as experience was gained and to provide a framework for the training of a corps of national on-farm researchers.

---

[1]Ministerio de Desarrollo Agropecuario, Banco de Desarrollo Agropecuario, and Instituto de Mercado Agropecuario.

In 1978, the first such program began in the area of Caisan with the cooperation of CIMMYT, and a former CIMMYT trainee was assigned as coordinator of the program. At the same time, the issues which would shape IDIAP's institutional organization were being discussed, and Caisan, its first area-specific on-farm project, was expected to be a source of experience for the development of research procedures for IDIAP.

The Caisan program was planned and carried out strictly within the limits of the human and financial resources normally available to IDIAP. Thus, the cooperation of CIMMYT (development of procedures and in-service training)[2] was designed in such a way to not exceed normal resource allocation for area- specific programs.

Since the Caisan Program was designed to be one of learning by doing, no detailed, predetermined methodology was specified for use in the various research stages. Nevertheless, certain characteristics were defined which conditioned the procedures to be followed. They were:

1. To be area specific with the purpose of increasing, in the short run, productivity and income of representative farmers of Caisan.

2. To use a farming system perspective, focusing on priority crops and concentrating on the most promising research opportunities in terms of their potential for increasing productivity and income for target farmers.[3]

3. To use on-farm research procedures including: a) surveys to ascertain farmer circumstances and prevailing cropping patterns, and b) on-farm experiments carried out on fields of representative farmers and featuring major research opportunities identified through the surveys.

## II. THE CAISAN PROGRAM: PLANNING STAGE

In the following sections, the lessons learned in carrying out the Caisan program will be described in terms of methodology used and specific technologies developed for the farmers of the area.

### Information Gathering at the Farmer Level

In order to understand the agro economic circumstances of farmers in the Caisan area, available secondary information was analyzed as a first step. The area includes about 10,000 hectares with some 300 farmers from the communities of Fila Caisan, Caisan Arriba, Primavera, Caisan Centro, Plaza Caisan, Alto la Mina, Bajo la Mina, Caisan Abajo, and Bajo Chiriqui.

---

[2]For more detail see Martinez, Juan Carlos, and Gustavo Sain, "Evaluación Economica de los Programas por Area del IDIAP: El Caso Del Programa de Caisan." Documento Preliminar, CIMMYT, Mexico, Diciembre 1982, Section III.

[3]Byerlee, D., I Harrington, and D. Winkelmann, "Farming Systems Research: Issues in Research Strategy and Technology Design." American Journal of Agricultural Economics 64 (5): 897-904, 1982.

The agricultural zone is concentrated in the western part of Caisan, where the land is flat or slightly hilly. The rest of the area has irregular elevations and is used for perennial crops or for livestock. The annual average rainfall is 4,000 mm, and the temperature ranges from 18 C in the dry season to 22 C in the rainy season.

The soil of the region is of relatively homogeneous fertility, being of volcanic origin with a sandy texture and granular structure. It is deep black soil, well drained and with a high organic content. The most important crops are maize in the first cycle (March to September) and beans in the second (October to January). These were to constitute the target crops of the program.

Within the framework provided through secondary information, an informal survey was made to get further information about the farmers of the area, their prevailing production systems, and their most important production problems.

The exploratory survey led to a formal survey, more rigorously focused on the production problems of the area. It was designed to clarify certain aspects of prevailing production conditions which were identified in the exploratory survey and would be of value for further research. The informal survey took place in August, 1978, and the formal survey in December of the same year.

The formal survey concentrated on maize in the first cycle within the maize/bean rotation system. The survey sample was taken from a list of farmers included in the 1970 National Census and updated during the informal survey; a random sample of 52 farmers was selected for interview.

The formal survey verified and, in some cases, quantified the hypothesis formulated from the informal survey. Almost all of the farmers produced maize (98%) and, of those, the majority rotated the crop with beans on the same plot (70%). This confirmed the relative importance of the target crops, maize in the first cycle and beans in the second.

It was found that beans were planted after the maize harvest and after complete seed bed preparation. Therefore, within this cropping system, the two crops presented a minimum on interaction.

Use of Survey Information to Plan Experimental Work

1. Definition of Recommendation Domains--With the results of the questionnaire in hand, the first task was that of developing tentative recommendation domains, groups of farmers whose agro economic circumstances were sufficiently similar to permit the development of recommendations valid for all members of the group.[4] The first line of differentiation was by location. Secondary information had shown that Bajo Chiriqui had agro climatic characteristics similar to the rest of the zone, but that access roads into the area were often impassable, posing serious market access difficulties. This led to the hypothesis that farmer circumstances for Baja Chiriqui (Recommendation Domain 1) were different than those of the rest of the study area (Recommendation Domain 2).

---

[4]Byerlee, Derek, Michael Collinson et al, "Planning Technologies Appropriate to Farmers: Concepts and Procedures." CIMMYT, Mexico, 1981.

This hypothesis was verified by the results of the survey which showed that there were marked differences in the use of inputs by farmers of the two areas (Table 1). Because of the differences, technologies feasible for the two groups for the near future were different. Since the Caisan research program staff worked with limited resources, efforts were concentrated on Recommendation Domain 2.

Table 1. First Definition of Recommendation Domains: Comparison of Maize Production Practices for Bajo Chiriqui and the Rest of the Caisan Area, Maize, First Cycle

| TECHNOLOGICAL PRACTICE | RECOMMENDATION DOMAIN 1: BAJO CHIRIQUI | RECOMMENDATION DOMAIN 2: REST OF THE AREA |
|---|---|---|
| | (percent of farmers using the practice) | |
| Mechanized Land Preparation | 0 | 74 |
| Use of Herbicides | 0 | 66 |
| Use of Fertilizers | 0 | 57 |
| Use of Insecticides | 0 | 20 |

Source: Caisan farm survey, December 1978

2. Research Opportunities--As mentioned earlier, experimentation must be carried out in relation to the representative agro economic circumstances of the recommendation domain(s), concentrating on the most promising research opportunities in terms of potential increases in productivity and farm income.

The information obtained from the farmers themselves, along with the perceptions of the researchers, made possible the limiting of research components to a minimum number for incorporation in the on-farm experimental phase. Those technological components to be incorporated in the first round of trials were determined as well as tentative ideas for future research cycles to be verified during the first round of trials.

2.1. Technological Components for the First Cycle of On-Farm Experiments

Weed Control--Weeds constituted a major problem in Caisan maize production. The natural fertility of the soil plus the ample rainfall led to a high incidence of weeds in farmers' fields--a problem clearly perceived by the farmers themselves and confirmed by the formal survey (Table 2).Given the socioeconomic circumstances of representative farmers, e.g., scarcity of farm labor and high labor cost, timely weeding by hand was not feasible.

Caisan farmers, from the point of view of the weed problem, faced a situation that may be defined as "transitional"--they were already seeking methods other than hand weeding to improve overall weed control and increase the productivity of the limited farm labor force. For that reason, the majority were already using 2,4-D in applications of one liter per hectare, 30 days after planting.

Table 2. Limiting Factors In Maize Production, Farmer Opinion

| PROBLEMS | GRADE OF INTENSITY SERIOUS No. Reports | % | NOT SERIOUS No. Reports | % | TOTAL REPORTS No. | % |
|---|---|---|---|---|---|---|
| Weeds | 30 | 85.7 | 3 | 8.6 | 33 | 94.3 |
| Lodging | 27 | 77.1 | 6 | 17.1 | 33 | 94.3 |
| Shortage of Farm Labor | 18 | 51.4 | 7 | 20.0 | 25 | 71.4 |
| Erosion | 11 | 31.4 | 10 | 28.6 | 21 | 60.0 |
| Insects | 10 | 28.6 | 9 | 25.7 | 19 | 54.3 |
| Lack of Machinery | 14 | 40.0 | 2 | 5.7 | 16 | 45.7 |
| Other | 6 | 17.2 | 7 | 20.0 | 13 | 37.2 |

Source: Caisan farm survey, December 1978

As a result of this situation, there was an opportunity for developing, in the short term, alternative technologies in chemical weed control for increasing maize production and labor productivity, with clear economic benefits for the farmer. These alternatives were initially centered around the use of a selective herbicide, atrazine, although other chemical control possibilities were also analyzed.

Spatial Arrangement-Density--Almost all of the farmers used "mateado" planting, irregularly spaced hand planting. The hills were spaced about one meter apart, with four seeds per hill, thus giving a density of about 40,000 plants per hectare at seeding.

In this case, the research hypothesis was related to the weed control problem. The irregular planting arrangement made chemical weed control difficult and so program researchers proposed planting in rows. It was also felt that adequate chemical weed control would permit a greater plant density than then used by the farmer.

Fertilizer Requirements--As a result of the survey, the problem of fertilizer use was seen to have several distinct facets:

1. From the production point of view, the farmer seemed to be familiar with the use of chemical fertilizers; nevertheless, a large percentage (42%) did not use any. Those who used fertilizers (58%) applied it at a rate well below the recommended 400 lbs/ha of 10-30-10 or 12-24-12. The hypothesis of the researchers was that response to fertilizers, if any, would not be substantial.

2. From the point of view of credit policy, the maize programs in the area had emphasized two things, mechanization and fertilizer use.

While mechanization had been fully adopted by the farmers, the same was not true of fertilizers. As the bank was experiencing a high rate of repayment default in the area, it was important to clarify the importance of fertilizer use in the Recommendation Domain, especially as to whether, considering the farmers' practice (low dosage), the rate of return associated with additional fertilizer use would be greater than the opportunity cost of capital.

Lodging--The strong winds in the area, particularly during June and July, represented an important risk in the production process. In the farmers' eyes, lodging was one of the most important problems, second only to weeds (Table 2). Table 3 shows the frequency of wind damage in the last five years and the months in which it occurred. Nearly 80% of the reported cases of wind damage took place during June or July. The frequency of damage was variable, although during the given period all the farmers had suffered some damage on at least one occasion, the magnitude of harvest losses depending on the size of the affected areas and also on the state of maturity of the maize at the time. Among the elements that contributed to increased incidence of wind damage in the zone was the excessive height (usually over 3.5 meters) of the maize variety used by the farmers.

In spite of the fact that other shorter varieties had been tried in the area (among them Tocumen 7428), they had not been accepted by the farmers. According to reports they were not sufficiently resistant to the excessive humidity characteristic of the area--the ears rotted and the husks did not close well--and yield did not surpass that of the local variety.

In view of the experience of the farmers with other varieties, it was decided not to experiment with new varieties in the first stages of the work, but to design a modest program for the reduction of the plant height of the local variety. Information obtained in the survey had also suggested that, in the short term, the increase in productivity and income from other research components (such as weed control and plant density) would be superior to that from the use of new varieties.

Table 3. Date and Frequency of Lodging

| | NUMBER OF YEARS IN WHICH WIND DAMAGE HAD OCCURRED IN THE MONTH LAST FIVE YEARS | | | | | | |
|---|---|---|---|---|---|---|---|
| Month | 1 | 2 | 3 | 4 | 5 | No Response | Total |
| May | 2 | 1 | - | - | - | - | 3 |
| June | 6 | - | 2 | - | 5 | - | 13 |
| July | 1 | 4 | 3 | - | 5 | - | 13 |
| August | 1 | - | - | - | 2 | 2 | 5 |
| Total | 10 | 5 | 5 | - | 12 | 2 | 34 |

Source: Caisan farm survey, December 1978

2.2 Technological Components Beyond the First Cycle--The foregoing section has represented the prescreening of technological components for inclusion in the first cycle of maize experiments. The idea was to concentrate the research on a minimum number of new technological components which could be managed by the researchers assigned to the program, and thus quickly result in feasible technological alternatives for target farmers. By the very nature of the research strategy, it is clear that the selection of technological components did not exhaust all of the problems of the area nor did it completely determine the future of the research.

In particular, there was concern about erosion as reported by the farmers (Table 2) and confirmed by direct observation; this together with the lack of machinery and scarcity of farm labor led to the consideration of future research and zero tillage as an alternative to the conventional tillage presently practiced.

It was decided to postpone the incorporation of tillage practice as an experimental variable until more information could be obtained to permit the validation of hypothesis associating it with chemical weed control. The technical aspects of the practice needed to be better understood before becoming involved in the relatively more complex research issues associated with zero tillage.

Information that was generated at the planning stage had not fully clarified the nature and magnitude of the insect problem, particularly soil insects. It was hoped that the first cycle of experiments would shed additional light on this research issue for inclusion in future phases of the research program.

Research Strategy and Trial Management

Through the research process described in the previous section, five technological components were selected for inclusion in the initial stages of research:

1) Weed control
2) Spatial arrangement - density
3) Nitrogen requirements
4) Phosphorous requirements
5) Lodging

It was decided that the last component would be handled separately from the others in a special maize improvement program to reduce plant height. If successful, the effort would permit a reduction in the production risk associated with lodging. Given the nature of plant breeding, the payoffs from this effort would be in the intermediate term.

The remaining research components, all involving on-farm trials, were organized into two groups according to the nature of the problem being addressed, the time period in which research payoffs could be expected, and the research priority assigned to the component.

The first group included the components weed control and spatial arrangement-density, which were expected to play a key role in the program in terms of their potential far increasing productivity and income. Also, the problems to be confronted in the two areas were strictly ones of production; no limitations

were anticipated in terms of policy or availability of inputs. Research on the components was set for the near term with results leading to recommendations expected after two cycles of experimentation. The above considerations led to these two components being assigned first priority in the research program.

For the medium-term research horizon, and of second priority in the initial research phase, were the components of nitrogen and phosphorous requirements. Interest in those components was not restricted to the area of production, but was also related to agricultural policy. Credit programs in the region had traditionally emphasized the use of fertilizers; nevertheless, even though the farmers were familiar with fertilizers, almost half did not use them, and of those who did, amounts less than those recommended were used. There was no evidence of fertilizer response in the area, and the perception of the researchers was that, given the natural fertility of the land, even if such a response existed it might not be substantial. Therefore, the inclusion in the research program of fertilizer treatments as experimental variables was addressed more towards policy makers than farmers. This more complex nature of the fertilizer problem (production/policy issues) decided the medium-term horizon assigned to this group.

The grouping of the components was not merely taxonomic, but rather had implications for the management of the experiments. The four technological components were incorporated as experimental variables in uniform trials of an exploratory nature, with the main effects and interactions studied through a factorial arrangement $2^4$, in relation to the farmers' practice. The exploratory experiments were complemented by levels trials in which experiments were carried out on various types of herbicides, amounts and times of application, and application rates for nitrogen and phosphorous.

In the trials incorporating weed control and spatial arrangement-density as experimental variables, the nature and levels of non-experimental variables were set at the prevailing and representative practices of area farmers. This allowed the results of the trials to be evaluated directly in terms of their potential impact for representative farmers in the recommendation domain.

The fertilizer studies, oriented toward the medium term, were handled "as if" the farmers had adopted better weed control alternatives. Consequently, the corresponding non-experimental variables were fixed at optimal levels according to available information at the planning stage. Finally, the check levels in the experimental variables were in all cases the corresponding farmers' practice.

## III. FIRST CYCLE RESULTS AND THEIR IMPLICATIONS

### Exploratory Trials

The exploratory trials of 1978 attempted to analyze the agro economic impact of the new technological components for representative farmers in the recommendation domain, as well as to see the interactions among the components. The exploratory analysis had a double purpose: 1) to verify the hypothesis set at the planning stage of the program in the identification of priority problems and 2) to analyze the agro economic feasibility of developing corresponding technological alternatives. In other words, the hope was to identify the priority problems and, at the same time, contribute information for their eventual solution.

ON-FARM RESEARCH PROGRAM
CAISAN, PANAMA

## EXPERIMENTAL STRATEGY AND TRIAL MANAGEMENT, MAIZE FIRST CYCLE

PRESCREENING OF TECHNOLOGICAL COMPONENTS; TIMING OF RESEARCH; PURELY PRODUCTION PROBLEMS VS PRODUCTION PROBLEMS ASSOCIATED TO AGRICULTURAL POLICY. MANAGEMENT OF EXPERIMENTAL AND NON-EXPERIMENTAL VARIABLES.

| PRESCREENED COMPONENTS | PROBLEM NATURE | TIMING OF RESEARCH | EXPLORATORY TRIALS ($2^4$) | | | LEVEL TRIALS | |
|---|---|---|---|---|---|---|---|
| | | | COMPONENTS INCLUDED | RANGE OF EXPERIMENTAL VARIABLES | NON-EXPERIMENTAL VARIABLES | COMPONENTS INCLUDED | NON-EXPERIMENTAL VARIABLES |
| A) WEED CONTROL<br>B) PLANT DENSITY AND SPATIAL DISTRIBUTION | PRODUCTION | SHORT TERM | A<br>B | FP AND ALTERNATIVE | FP | A | FP |
| C) NITROGEN REQUIREMENTS<br>D) PHOSPHOROUS REQUIREMENTS | PRODUCTION-AGRICULTURAL POLICY | MEDIUM TERM | C<br>D | | | C<br>D | FP + H1<br>AND<br>FP + H1 + D1 |
| E) LODGING | BREEDING | MEDIUM TERM | PROGRAM TO REDUCE PLANT HEIGHT OF LOCAL VARIETY | | | | |

NOTES – FP: Farmer Practice;
H1: Improved Practice in Weed Control;
D1: Improved practice in Plant Density and Spatial arrangement.
The Check Levels on the Experimental Variables Correspond to FP in all Trials.

Thus, six trials incorporating four of the five technological components chosen as priorities for the first cycle of experiments were carried out, utilizing an incompletely randomized block design with a factorial management of $2^4$ and without replications. The criteria for fixing levels of experimental variables was that 1) farmer practice was always used as one level, and 2) the other level was one that would permit the detection of main effects and interactions should they exist.

The reasons for not replicating the trials in each locality were of diverse nature: 1) in choosing between statistical vigor (more replications per site) and a wider sampling within the recommendation domain (more localities), the research team gave more weight to the latter; 2) researchers felt that trial plot size requested of farmers should be minimal in the initial stage of the research, when the farmers were not acquainted with either the staff or the nature of the program; 3) research sites were carefully selected to fit characteristics of the recommendation domain, presumably leading to less across-site variability and allowing sites to be treated as replications once across-site consistency was verified; and 4) the design-arrangement of the trials contained "hidden" replications which permitted partial statistical analysis per locality if necessary.

Of the trials, one was eliminated because of unusual damage by animals; of the remaining experiments, the lowest average yield was obtained using present farmer practices (2.9 t/ha) while the greatest yields were obtained when all alternatives to the farmers' practices were included (6.1 t/ha). Table 5 shows the results by location and the average for the recommendation domain.

Table 5 also illustrates the potential impact of the factors considered. On the one hand, there is marked yield advantage for the alternative herbicide and planting distribution-density practices, with the average yield advantage being 0.9 tons per hectare for each component. On the other hand, the effect of chemical fertilizer use is practically nil, with positive and negative values around zero, depending on the location. With this consistency in results obtained across locations, a statistical analysis was carried out for the group of experiments, treating the locations as repetitions. The results were presented in Table 6.

One can clearly see the high significance obtained for the weed control and planting distribution -density components. The interaction of the two components was statistically significant at the 10% level which, even if not conclusive, clearly indicates a research path to be continued. Since each factor of the interaction is highly significant, the agronomic explanation that stems from this relationship would seem to be that more efficient weed control might eliminate weed competence for light, space, and eventually nutrients, allowing a more densely planted and better distributed planting alternative.

With respect to the nitrogen and phosphorous components, Table 5 showed that there was virtually no impact on yield. The statistical analysis (Table 6) also indicates that there were no significant differences in yield due to the use of those chemical nutrients. There is an agronomic explanation for this fact, resulting from certain characteristics of the recommendation domain. First, Caisan is a relatively new maize production area with good soil structure and high natural fertility. In addition, in the maize/bean rotation, the bean crop probably contributes nitrogen to the maintenance of natural soil fertility; there could also be a residual effect from the phosphorous applied to the beans in the second cycle (around 10 kilos of N, 40 kilos of $P_2O_5$, and 10 kilos of $K_2O$).

Table 5. Exploratory Trails: Main Effects by Location

| MEANS OF TREATMENTS | AVERAGE YIELDS BY LOCATION | | | | | AVERAGE YIELD FOR THE RECOMMENDATION DOMAIN |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | |
| | (tons/ha, 14% humidity) | | | | | |
| $H_0$ | 4.1 | 3.8 | 3.8 | 3.6 | 4.1 | 3.9 |
| $H_1$ | 5.4 | 5.3 | 4.8 | 4.0 | 4.7 | 4.8 |
| Main Effect | 1.3 | 1.5 | 1.0 | 0.4 | 0.6 | 0.9 |
| $D_0$ | 4.3 | 3.8 | 3.4 | 3.6 | 4.2 | 3.9 |
| $D_1$ | 5.3 | 5.2 | 5.2 | 4.0 | 4.5 | 4.8 |
| Main Effect | 1.0 | 1.4 | 1.8 | 0.4 | 0.3 | 0.9 |
| $N_0$ | 4.9 | 4.3 | 4.3 | 4.0 | 4.3 | 4.3 |
| $N_1$ | 4.7 | 4.7 | 4.4 | 3.6 | 4.5 | 4.4 |
| Main Effect | -0.2 | 0.4 | 0.1 | -0.4 | 0.2 | 0.1 |
| $P_0$ | 4.7 | 4.7 | 4.2 | 3.7 | 4.0 | 4.3 |
| $P_1$ | 4.9 | 4.4 | 4.5 | 3.9 | 4.7 | 4.5 |
| Main Effect | 0.2 | -0.3 | 0.3 | 0.2 | 0.7 | 0.2 |

Source: Caisan trials, first cycle, 1979
(H — chemical weed control; D — spatial arrangement-density; N — nitrogen; P — phosphorous)

In analyzing the economic feasibility of the technological alternatives incorporated in the exploratory trials, the agronomic impact was used as the basis. In this manner, the components that showed significant yield impacts and first order interactions (weed control and spatial arrangement-density) were analyzed for their economic viability as compared to the actual farmer practices in the recommendation domain. Table 7 shows that the H1 and D1 alternatives presented an ample margin of profitability, with marginal rates of return (MRR) of around 700%. Based on the interactions detected in the agronomic and statistical analyses of the components, the MRR of $H_1D_1$ suggests that the components should be considered together.

Up to this point, the empirical evidence from the analysis of the first cycle of exploratory trials indicated, with an ample margin of confidence, clear opportunities for the development of new technological alternatives for chemical weed control and spatial arrangement-density.

For the rest of the variables considered in the exploratory trials, (nitrogen and phosphorous), there were no significant differences in yields. Without going through the economic analysis of the data, it can be tentatively inferred from the agronomic responses that the farmers' practice was the most reasonable technological alternative.[5]

[5]Likewise, if we act “as if” the differences were significant and complete the economic analysis, we will find that the increase in yield far from compensates the costs incurred in the purchase and application of the chemical nutrients under consideration.

Table 6. Exploratory Trials: Combined Anova for the Five Locations

| SOURCE OF VARIATION | DEGREES OF FREEDOM | SUM OF SQUARES | MEAN SQUARES | F. CALC. |
|---|---|---|---|---|
| Repetition | 4 | 8.5531 | 2.1383 | 2.2688 |
| Blocks | 5 | 2.4207 | 0.4841 | 0.5136 |
| H | 1 | 19.7011 | | 20.9031* |
| D | 1 | 19.5031 | | 20.6930* |
| N | 1 | 0.0211 | | 0.0224 |
| P | 1 | 0.9901 | | 1.0505 |
| HD | 1 | 2.8501 | | 3.0240 |
| HN | 1 | 1.0811 | | 1.1471 |
| HP | 1 | 0.0061 | | 0.0065 |
| DN | 1 | 0.0781 | | 0.0829 |
| DP | 1 | 0.0361 | | 0.0383 |
| NP | 1 | 0.0001 | | 0.0001 |
| HDN | 1 | 2.1451 | | 2.2760 |
| HDP | 1 | 0.5611 | | 0.5953 |
| HNP | 1 | 0.2101 | | 0.2229 |
| DNP | 1 | 3.0031 | | 3.1863 |
| Error | 56 | 52.7798 | 0.9424 | |
| TOTAL | 79 | 113.9400 | | |
| CV = 22% | | | | |

Source: Casian trials, first cycle, 1979
*Significance 0.01
H-chemical weed control;
D-spatial arrangement-density;
N-nitrogen;
P--phosphorous

Table 7. Economic Analysis of Exploratory Trials: Viability of Alternative Technologies in Chemical Weed Control and Spatial Arrangement-Density*

| CONCEPT | TECHNOLOGICAL ALTERNATIVES $H_0D_0$ | $H_0D_1$ | $H_1D_0$ | $H_1D_1$ |
|---|---|---|---|---|
| Yield, ton/ha | 3.6 | 4.2 | 4.2 | 5.5 |
| Adjust Yield (-10%) | 3.24 | 3.78 | 3.78 | 4.95 |
| GROSS BENEFIT (114/ton)** | 369.36 | 430.92 | 430.92 | 564.30 |
| VARIABLE COSTS (VC) | 15.23 | 23.05 | 31.57 | 39.39 |
| Weed Control | | | | |
| 2,4-D ($1.63/1t) | 1.63 | 1.63 | | |
| Gesaprim ($7.19/2.5 kg) | | | 17.97 | 17.97 |
| Planting | | | | |
| Seeding Rate, kg/ha | 13.00 | 16.00 | 13.00 | 16.00 |
| Cost/ha ($0.22/kg) | 2.86 | 3.52 | 2.86 | 3.52 |
| Labor, days/ha | 3 | 5 | 3 | 5 |
| Labor ($3.58/day) | 10.74 | 17.90 | 10.74 | 17.90 |
| NET BENEFIT (NB) | 354.13 | 407.87 | 399.35 | 524.91 |
| Increase in NB | | 53.74 | | 117.91 |
| Increase in VC | | 7.82 | | 16.34 |
| Marginal Rate of Return | | 687% | | 716% |

Source: Caisan trials, first cycle, 1979

* Nitrogen and phosphorous requirements show no significant differences between treatments and so were not included in the economic analysis

**Field price of maize

In short, the exploratory trials confirmed the original preliminary identification of the problems facing farmers in the recommendation domain and, at the same time, permitted the exploration of alternative technologies that promised significant economic benefits for the farmer.

Levels Trials

Complementing the information from the exploratory trials, the levels experiments provided greater depth and detail about the behavior of some of the experimental variables considered in the exploratory experiments. For the first cycle, levels trials were carried out for: a) types of herbicides and dosages, b) types of herbicides and application timing, and c) levels of nitrogen and phosphorous.

Types of Herbicides and Dosage--Two herbicide by dosage trials were planted using a complete randomized block design with four repetitions. The variables considered were application dosages and combinations of Gesaprim 80, Prowl, Alachor, and 2,4-D, including in the trials farmer practice (2,4-D 30 days after planting). The results showed significant differences for both locations (at the 1% significance level) between the farmers' practice and the alternative chemical controls considered in the experiments. The analysis by location showed that the farmer could significantly increase his yields by using alternative methods of chemical control. The combined analyses from the two locations show significant differences in the treatments.

With these results, economic analyses were carried out for the locations, both individually and combined. The Gesaprim 80 treatment, using a 2 kg/ha application during the pre-emergence stage, was superior to the other alternatives, with a marginal rate of return greater than 1250% at each location as well as in the combined analysis. This chemical control alternative is the same as that used in the exploratory trials, except that, in the latter case, the dosage was slightly higher (2.5 kg/ha). This application rate showed an equally high marginal rate of return.

Both groups of experimental trials (exploratory and levels) showed consistent results for this experimental variable, both in the qualitative (type of herbicide) and quantitative (dosage) aspects, and confirmed the viability for the farmer of more efficient alternatives of weed control.

Types of Herbicides and Timing of Application--Two herbicide experiments were conducted to compare alternative application timing patterns, using a complete randomized block design with four repetitions. The applications were made 0, 5, 10, 20, and 30 days after planting, and Gesaprim 80 and 2,4-D (including the farmer's practice) were used as well as a check treatment of no chemical control.

In both experiments, problems with lodging due to high winds affected the accuracy of the results. The lodging problems occurred near plant maturity and, consequently, the impact on average yield levels was not great. Nevertheless, from the point of view of trial management, the presence of lodged plants within the plots affected the accuracy of the agronomic and yield data obtained from the trials.

With this qualification, significant differences were not found for the different treatments, except when compared to the check treatment. The information obtained from this group of experiments did not contribute to the clarification of the issues involved as had been the case in the preceding trials.

Levels of Nitrogen and Phosphorous--Two nitrogen by phosphorous levels experiments were planned. The design utilized was the complete randomized block with an incomplete factorial arrangement and three repetitions. These included five levels of nitrogen and phosphorous (from 0 to 150 kg/ha) with a density of 37,500 plants per hectare. An additional treatment was added which consisted of intermediate level applications of nitrogen and phosphorous with a density of 50,000 plants per hectare.

The statistical analysis in both cases indicated that no significant differences existed between treatments. In this group of experiments some management problems were also experienced, e.g., insect attach and minor animal damage. In spite of those problems, the consistency of the results with those previously

reported for the exploratory trials added support to the original hypothesis that there were no significant differences in yield due to the use of nitrogen or phosphorous.

Integrating Survey and Experimental Results

The methodology used in the program included, after each cycle, the integration of the information from the surveys with the results of the on-farm experiments. The data were reviewed, new hypotheses formulated, and new lines of research charted, both for the on-farm research program and for experiment station research. Where appropriate, recommendations for farmers were made as well as those for agricultural policy.

The exploratory trials showed significant first order effects for herbicides and spatial arrangement-density and, to a lesser degree, interactions between those variables. The marginal rates of return for the research components, planting 40,000 plants/ha and using Gesaprim 80 at 2.5 kg/ha, were above 700%. This confirmed the hypothesis that clear opportunities existed in these technological components for the development of viable alternative technologies for representative farmers to increase the productivity of the land and labor devoted to maize production.

The results of the levels trials on herbicides were qualitatively (types of herbicides) and quantitatively (dosage of 2 kg/ha in this case) consistent with the results of the exploratory trials. This, along with the high economic margin of profitability for the various components, led IDIAP to formulate recommendations for area farmers after only one cycle of experiments.

The use of chemical fertilizers, in the exploratory trials as well as in levels trials, gave a nonsignificant response confirming the original hypothesis formulated in the planning stage-- the use of nitrogen and phosphorous, separately as well in combination, resulted in negative marginal rates of return. These results remained the same even when fertilizer was used with improved weed control and spatial arrangement-density practices. This represented a challenge for recommendations on the use of fertilizers, at least until the information suggested that emphasis placed on fertilizer use in credit programs be re-examined.

Finally, the results obtained using the local maize variety in the first cycle of trials confirmed the hypothesized yield potential of the farmers' variety.

For the future orientation of the research program, the results of the first cycle, together with the diagnostic surveys done in the planning stage, suggested the following lines of research for the second cycle:

1. Given that the hypothesis about the agroeconomic impact of adequate weed control seemed to be validated, and considering erosion problems and the lack of machinery, it was decided to incorporate the tillage system as an experimental variable in the next cycle. This would entail analyzing the prevailing conventional tillage system (mechanized) against an alternative of zero tillage with chemical weed control.

2. Given the impact obtained from the trials on herbicides and spatial arrangement-density, and the interactions observed between the

components, the levels experiments for the next cycle would examine the variables jointly (herbicides by density) in order to determine more precisely the relationships between them and confirm optimum levels.

3. Given the efficiency shown by the contact herbicide, Gramoxone, in the control of prevalent weeds in the bean cycle and its relative lower price, it would be incorporated into the program as a complement and/or alternative to Gesaprim 80.

4. Given the impact that Gesaprim had in the first cycle, and the prevalent maize/bean rotation system, it was decided to analyze the residual effect that Gesaprim had on the bean crop, using a factorial arrangement (dosage of Gesaprim per days after its application in which beans are planted). In order to save time and reduce research costs, this factorial arrangement would be carried out on the border rows of the herbicide by density trials. The hypothesis was that high precipitation would eliminate any residual effects on the beans.

5. Given the impact of spatial arrangement-density, plant population would be more closely monitored in future experiments, particularly during the first month of crop development.

6. Given the results of the fertilizer trials, the medium-term horizon used for those variables, experiments would be carried out on continuous plots to analyze, in the longer term, the impact on natural soil fertility of more intensive production practices in the maize/bean crop rotation.

## IV. BEYOND THE FIRST CYCLE: TECHNOLOGY VERIFICATION, TRANSFER, AND ADOPTION

Research results described in the previous section provide a solid basis for the orientation of the Caisan research program in subsequent cycles. Further, they provide empirical evidence of the utility of the research methodology used by the program. Accordingly, the same research strategy was followed for subsequent research cycles.

### Most Important Implications of the Second and Third Cycle of Trials

The most important change in the second cycle of trials was the inclusion of tillage systems as an experimental variable. The tillage experimental variable was incorporated in the exploratory trials in place of weed control, although the latter variable continued to be part of the "levels" trials.

The hypothesis regarding zero tillage as an alternative to conventional tillage was that it would be "cost saving" rather than "yield increasing." In particular, researchers felt its use as an alternative technology would have the following results:

1) Maintain basically the same yield levels.

2) Reduce the cost of tillage practices per hectare and, consequently (if point one is verified), reduce average production costs.

3) Significantly reduce soil erosion, identified in the initial planning phase as a problem by both farmers and researchers.

4) Relieve the small farmer of having to depend on contracted mechanization service for land preparation.

5) Increase farmers' time flexibility at planting by considerably shortening the time required for land preparation.

6) Decrease the competence of weeds during the first weeks of plant stand development, as a result of fewer days between land preparation and planting.

With these hypotheses about zero tillage, four exploratory trials were planted that included this variable along with spatial arrangement-density and nitrogen and phosphorous requirements. The results of three of the trials (one was lost due to heavy lodging) confirmed the results of the previous cycle with respect to the last three variables. The new experimental variable, the tillage system, showed statistically significant differences (5%) in yield levels at only one of the harvested locations. In that case, the main effect was positive, with higher yields for zero tillage. In the other two locations, no significant differences were encountered nor did across-site analysis show significant yield differences. The results, therefore, were consistent with the research hypothesis that zero tillage would not significantly affect yields.

With respect to the economic dimension, Table 8 shows partial budgets for conventional tillage and zero tillage, assuming that yield would remain the same under both tillage systems. A comparison of the costs associated with the two systems shows that zero tillage results in a 44% reduction as compared to the conventional tillage system. This reduction is only in terms of immediate savings, not taking into account the implicit cost of erosion associated with conventional tillage, a cost clearly apparent to representative farmers in the area.

In the levels trials, three herbicide by plant density and three fertilizer trials were planted. The herbicide by density trials were included to confirm the interactive effects observed for those variables in the exploratory trials conducted during the first cycle. Also the herbicide, Gramoxone (paraquat), was included in order to compare its effectiveness with the previously used herbicide, Gesaprim 80.

Unfortunately, the loss of a considerable number of plots in the levels trials due to heavy lodging made it impossible to carry out the quantitative analysis, and only the field observations made during the growing stages were available for use by the research team. Those observations indicated that both the preemergence applications of Gesaprim and the post emergence applications of Graxomone provided effective weed control. The same effectiveness was not observed for 2,4-D, confirming the results obtained in the previous cycle. With respect to the residual effects of Gesaprim on the subsequent bean crop, the trials showed that after 90 days there was practically no residual toxicity in the soil.

Once again, fertilizer trials showed no economic response, reinforcing previous conclusions on those components. These results, together with an increased

Table 8. Exploratory trials: Partial Budgets for Conventional and Zero Tillage Systems

| ACTIVITY | AMOUNT | UNIT COST | VARIABLE COSTS |
|---|---|---|---|
| Conventional Tillage | | | 45.00 |
| Plowing, 3 Passes | 3 hrs, tractor | 15.00 | 45.00 |
| Zero Tillage | | | 26.00 |
| Chopping | 2 days | 4.00/day | 8.00 |
| Herbicide | 1.8 liters | 5.00/1 | 9.00 |
| Labor, Herbicide Application | 2 days | 4.00/day | 8.00 |
| Rent, Backpack Sprayer | 1 day | 1.00/day | 1.00 |

Source: Caisan trials, first cycle, 1980

flexibility in the credit program operating in the area,[6] may lead, in the near term, to a decrease in fertilizer use with no effect on yields.

The above results had the following implications for the orientation of the program in the third cycle of experiments:

1. Add the control of soil insects as an experimental variable in the exploratory trials. The spatial arrangement-density variable proved to be significant for yield potential in the two previous cycles, and insect control would help assure improved plant stand.

2. Maintain tillage systems and spatial arrangement-density as experimental variables in the exploratory trials. The second experimental variable is related to soil insect control and demands more frequent countings of plant population during the first month after planting to determine the effectiveness of the insecticide control.

3. Maintain phosphorous requirements as an experimental variable in the exploratory trials, but eliminate nitrogen.

4. Repeat the herbicide by plant density trials that were lost in the previous cycle due to heavy lodging. Also, repeat the experiments on residual toxicity to beans on the border rows of those trials.

5. Continue the medium-term fertility studies on continuous plots of flat land (slope less than 5%) and initiate fertilizer trials on sloping land (slope more than 5%).

6. For evaluating technological alternatives, conduct verification trials (based on information obtained in the first two cycles) combining tillage systems, spatial arrangement-density, weed control, and fertilizer use.

[6]Starting in 1980, the credit program for maize deemphasized fertilizer use.

7. Enlist representative farmers to plant demonstration plots on zero tillage, under the supervision of the research team but with costs assumed by the farmers themselves.

With this basic orientation, experiments planted in the third cycle included: five exploratory trials; four levels trials on herbicides by density, which also tested residual toxicity to beans on the border rows; three fertilizer experiments on continuous flat land plots and two experiments on sloping land; three verification trials and three demonstration plots on zero tillage.

There were adverse growing conditions throughout the area during this cycle, with drought, insect attack (Agrothis sp., gallina ciega), and heavy incidence of Helminthosporium spp. These factors made the analysis of trial results difficult. Among the experimental variables included in the exploratory trials, insect control treatment using an insecticide showed a strong marginal rate of return due to the heavy incidence of insect attack. In other years, when insects are not as prevalent, there might be little return to insecticide application. Consequently, insecticide use represents "insurance" for adequate plant stand, although the probability of insect attack has not been clearly assessed. For the other variables, the analysis of exploratory and levels trials verified the conclusions of previous cycles.[7]

Verification Trials

The three verification trials conducted during the third cycle combined the best technological alternatives identified in the exploratory and levels trials and were designed to confirm their Agroeconomic viability for representative farmers. Consequently, the plot size in the verification trials was larger than in the previous trials, and the farmers had greater participation in their management.

In accordance with the results of the first two cycles of experimentation, the verification trials included technological alternatives on tillage systems, chemical weed control, spatial arrangement-density, and fertilizer applications. In light of the fact that the new herbicides were already displacing 2,4-D in the area, the incorporated farmers' weed control practice was changed to that of Gramoxone use. The rest of farmers' practices were kept as defined at the planning stage. The design of the three verification trials was as follows:

1. Farmer Practice (FP)

   a. Conventional tillage
   b. Chemical weed control with Gramoxone: 1 lt/ha 30 days after planting
   c. Fertilization: 200 lbs of 10-30-10 at planting
   d. 40,000 plants per ha, planting arrangement "mateado," hills about one meter apart, four seeds per hill

2. Technological Alternative 1 (TA 1)

   a. Zero tillage
   b. Chemical weed control with Gesaprim 80: 2 kg/ha after planting
   c. No fertilization
   d. 50,000 plants per ha, planted in rows

[7]For a detailed description of these results see Martinez, Juan Carlos, and Jose Arrauz, "Innovaciones Institucionales en la Investigación Agricola Panamena: El IDIAP en Caisan." Forthcoming.

3. Technological Alternative 2 (TA 2)

   a. Zero tillage
   b. Chemical weed control with Gesaprim 80: 2kg/ha after planting
   c. Fertilization: 200 lbs of 10-30-10
   d. 50,000 plants per ha, planted in rows

According to previous research results, it was hypothesized that TA 1 would successfully compete with FP in terms of decreased cost per ha, but only marginally in terms of yield. TA 2 implied greater costs per ha than TA 1, due to fertilizer application, and increase in yield was not expected to be significant.

The yields, variable costs, and net benefits associated with the three production alternatives considered in the verification trials planted at three locations are shown in Table 9. As can be seen from the data, yields varied considerably across locations and were particularly affected by the degree of disease incidence (Helminthosporium spp.). The combined economic analysis indicates that TA 1 dominated the other alternatives. When the trial results from Location 1 were removed from the across-site analysis (it had the most serious disease incidence), TA 1 showed even greater dominance. These results confirmed, therefore, that the superiority of alternative TA 1 was basically due to decreased costs per hectare (zero tillage, no fertilizer).

Demonstration Plots

During the third cycle, three representative farmers in the area agreed to grow their crop using zero tillage. These demonstrations, to be fully valid, were to be totally managed by the cooperator with only some technical advice from the research team.[8] The cooperating farmers paid for the majority of the production inputs and assumed production risks. The research team maintained informal contact with the cooperators throughout the growing season, particularly during zero tillage practices, in order to monitor their reactions to the use of the new technology.

The size of the demonstration plots varied between one and two hectares. The type of zero village practices followed for each demonstration plot varied slightly according to previous land management (animal grazing or not) and the level of weeds encountered. Only in Location 1 was it necessary to clear weeds and stubble from the previous growing cycle before herbicide application. In Location 2 farm animals had grazed the land after the previous bean crop harvest. The amount of Gramoxone used for the demonstrations varied between 1 and 2 lt/ha. In consequence, the cost of zero tillage varied between $19.25 and $26.50 per hectare, with the average being lower than the $26/ha cost estimated during the analysis of the 1980 exploratory trials (Table 8).

Farmer Response: Adoption of Recommended Practices

Evidence from CIMMYT technology adoption studies shows that, when technological recommendations are not adopted by farmers, it is usually because at least some component in the recommendation is not consistent with the

[8]The level of farmer interest in the new technological alternative is shown by the fact that some co-operators tested the technology on their own without any technical assistance from the research team.

Table 9. Economic Analysis of Verification Trials

| Concept | TECHNOLOGICAL ALTERNATIVES | | |
|---|---|---|---|
| | FP | TA 1 | TA 2 |
| Yield, t/ha | | | |
| Location 1 (heavy disease) | 1.91 | 1.42 | 2.93 |
| Location 2 (light disease) | 4.25 | 4.24 | 3.89 |
| Location 3 (light disease) | 2.86 | 4.02 | 3.34 |
| Average Yield, t/ha | 3.01 | 3.23 | 3.39 |
| Adjusted Yield (-10%) | 2.71 | 2.91 | 3.05 |
| GROSS BENEFIT ($193/ton)* | 524.70 | 563.40 | 590.50 |
| VARIABLE COSTS | 126.70 | 65.60 | 129.50 |
| Soil Preparation | 48.00 | 29.30 | 29.30 |
| FP (3 tractor passes) | 48.00 | | |
| Chopping, 2 days | - | 10.00 | 10.00 |
| Gramoxone (1.5 lt/ha) | - | 8.30 | 8.30 |
| Labor (herb. app., 2 days) | - | 10.00 | 10.00 |
| Rent, Backpack Sprayer | - | 1.00 | 1.00 |
| Planting | 19.30 | 30.30 | 30.30 |
| Seeding Rate, kg/ha | 13.00 | 16.00 | 16.00 |
| Cost/ha ($0.33/kg) | 4.30 | 5.30 | 5.30 |
| Labor, days/ha | 3 | 5 | 5 |
| Labor ($5/day) | 15.00 | 25.00 | 25.00 |
| Weed Control | 5.50 | 16.00 | 16.00 |
| Gramoxone (1 lt/ha) | 5.50 | | - |
| Gesaprim (2 kg/ha) | - | 16.00 | 16.00 |
| Fertilizer | 53.90 | | 53.90 |
| 200 lbs 10-30-10 | 43.90 | - | 43.90 |
| Labor, 2 days | 10.00 | - | 10.00 |
| NET BENEFIT | 398.00** | 497.80 | 461.00** |

Source: Caisan trials, first cycle, 1981
* Field price of maize
**Dominated alternatives

circumstances of the farmers to whom the technology is directed.[9] The Caisan research program was guided by the principle that the best guarantee for the adoption of recommended technologies was to assure that farmer circumstances were taken into account from the outset, leading to recommendations which were appropriate to those circumstances.

[9]Perrin, R.K., and D.L. Winkelmann, "Impediments to Technical Progress on Small versus Large Farms," American Journal of Agricultural Economics, 58:5, 1976.

The relationship between the researchers and representative farmers was central to the research paradigm of the Caisan project. This interaction began with the survey sequence, and it continued through the on-farm experiments and the monitoring of the adoption of the recommendations derived from the program. Thus, the research process began and ended with the farmer.

The technology transfer process followed in the project involved farmer field days at experiment and demonstration sites to discuss the alternative technologies involved. With these elements, and the degree of communication which existed between farmers in the area,[10] their response exceeded initial expectations. Furthermore, farmers themselves played an active role in the process of technology generation. For example, cooperating farmers modified the Gramoxone container so that it could be used as an applicator in the field. Similar farmer-originated adaptations occurred in zero tillage. Some farmers (particularly larger landholders) found it difficult to find the labor required by the manual chopping of old stands, the initial step of the zero tillage alternative. In consultation with the research team, they used a light harrowing pass instead of hand chopping to cut back the weeds and crops residues, thus arriving at a minimum tillage system.

Given the response of representative farmers to the technological alternatives developed through the research project, IDIAP decided, after only three cycles of research activity, to conduct an evaluation of the project, including the assessment of the social rate of return for its investment in the program.[11] The evaluation focused on two basic aspects: 1) the impact on area farmers of the adoption of recommendations formulated by the program, and 2) the methodological and institutional spillovers of the program to other regions of the country.

Table 10. Adoption Survey: Levels of Recommended Technologies

| TECHNOLOGICAL ALTERNATIVES | FARMERS | MAIZE AREA |
|---|---|---|
| | (percent) | |
| Appropriate Weed Control | 61.4 | 60.9 |
| Planting in Rows/Higher Density | 70.5 | 62.7 |
| No Fertilizer Used | 79.5 | 79.5 |
| Zero or Minimum Tillage | 43.5 | 23.0 |

Source: Caisan survey, first cycle, 1982

The evaluation included an adoption survey related to the technologies generated by the project. Table 10 illustrates the level of adoption by 1982 for

[10]The farmers were organized in three "Juntas Agrarias," mainly for buying inputs and obtaining credit.

[11]Martinez, Juan Carlos, and Gustavo Sain, "Evaluacion Economica de los Programas de Investigacion en Fincas del IDIAP: El Caso de Caisan", CIMMYT and IDIAP, 1982.

four of the components. Through contrast with data from the original 1978 survey, the patterns of adoption over time were also derived.[12] The difference in the percentage of farmers adopting minimum or zero tillage (43%), and its percentage of cultivated area (23%), reflects the fact that small and holders had the least difficulty in adopting the practice. This was probably because they relied on hand labor, and the adoption of minimum or zero tillage practices was appropriate to their circumstances. In contrast, those farmers with larger holdings had more difficulty in switching to minimum or zero tillage because labor constraints were more serious for them, and a mechanized zero tillage alternative was not yet available. (Subsequently, IDIAP purchased mechanized zero/minimum tillage equipment for examination in the project area starting in 1983.)

The high rate of adoption of recommended practices among Caisan farmers, particularly considering that the research project had only been in operation for four years (three cycles), stands as testimony to the validity of the research methodology which led in such a short time to the development of appropriate technology for target farmers--the final judges of the usefulness of production-oriented research.

## V. CONCLUSIONS: COST EFFICIENCY AND PROJECTIONS OF THE CAISAN PROGRAM

Within national agricultural research programs, there has been considerable progress during the last five years in the relative importance of on-farm research activities and the development of operational methodologies for its implementation. As this process evolves, methodological and technical problems are resolved and new pressing issues take their place; among them, those related to the institutionalization of on-farm research within national research structures. Undoubtedly, the starting point for this institutionalization process is the experience arising from the ongoing on-farm research programs, usually managed at the initial stage by ad-hoc technical groups from within the research structure.

From CIMMYT's perspective, the process builds up in a bottom up approach, from basic methodological ideas, to on-farm research all the way up (including training) to the institutionalization of these activities within the national program. In other words, it goes from on-farm research actions to an articulated on-farm research program.

IDIAP and Caisan illustrate this process. The institutional strategy of IDIAP provided the framework for the development of Caisan, and the work was closely followed up from the beginning by the national directing staff. Progress in the program and resulting methodological experiences were intensively discussed by researchers and directing staff in national meetings, field days, and regional workshops.

In this way, the Caisan program has contributed to the strengthening of the initial orientation of IDIAP towards site-specific, on-farm research. Also, in the methodological dimension, it provided concrete experiences, not only in terms of what to do in on-farm research (surveys, experiments, etc.), but, more importantly,

---

[12]Ibid., Section IV.

how to do it (the informal survey leading to a well-focused formal questionnaire, the prescreening of best-bet technological components based on the assessment of farmer circumstances, the management of experimental and non-experimental variables within the trials, etc.).

The program provides solid evidence of the validity of the research procedures used. Farmer's response, in terms of adoption of resulting technologies, is proof of the degree in which the program recommendations fitted their circumstances. On the other hand, the speed at which adoption took place is a clear indication that the research opportunities incorporated in the program represented important production problems for representative area farmers.

The best indicator of the cost efficiency of the methodology utilized is the social rate of return on the investment required to implement the program; the evaluation carried out in 1982 provides this information.[13] In fewer than four years, even assuming that there would be no further adoption after 1982, the social returns (basically accruing to area farmers) were much greater than the amount invested by IDIAP. The rate of return, using the most conservative figures, was 188 percent, clearly exceeding the opportunity cost of capital. When less conservative assumptions are made, the rate of return rises to 332 percent.[14]

These results reaffirm the conviction, one based also on experiences of other countries, 15 that the approach used was efficient in terms of costs and adequate for reaching target farmers with appropriate technologies in the near term.

While the Caisan program was being implemented, IDIAP was going through a systematic planning effort which resulted in an organization of its activities into Programs (Agriculture and Livestock), Subprograms (crops groupings—for example, basic grains), and Commodity Research Projects. While these are the groupings at the national level, they are cut across by the "Regional Research Programs" whose basic operational unit is the area-specific, on-farm research project.[16] The central management is composed by a Director General, assisted by a Deputy Director General, and National Directors of Agricultural Research, Animal Production Research, Planning, Transfer of Technology, Administration and Special Projects.

The area-specific on-farm research activities have gone through a considerable expansion since Caisan was begun in 1978 with two national researchers. At present they cover five priority areas in agriculture, involving the work of 24 national researchers, and three priority areas in livestock with 21 researchers.

---

[13]Ibid.

[14]Ibid.

[15]For example see Edgardo Moscardi et al, "Creating an On-Farm Research Program in Ecuador. The Case of INIAP's Production Research Program." CIMMYT Economics Program Working Paper, January 1983.

[16]"Plan Anual de Trabajo 1982," IDIAP, Panama, May 1982.

While this growth leaves no doubt as to the importance given to such activities by IDIAP, it also brings to the surface a set of pressing issues on the institutionalization of on-farm research which demand the attention of IDIAP central management. With this concern in mind, a workshop of IDIAP directive staff was organized, with the cooperation of CIMMYT, for an intensive discussion of all the issues (organizational, managerial, and technical) coming out from the field experiences of on-farm research.[17] While discussions were centered around Caisan results, other experiences from IDIAP and the institutional experience from INIAP Ecuador were considered as well.

The meeting proved to be a useful exercise for all the participants involved (which included, in addition to all IDIAP directive staff, a small group of resident international staff from CATIE, Rutgers University, and AID). The moving from on-farm research actions (i.e., Caisan) to an articulated on-farm research program presents many fronts to be looked upon; the workshop discussions showed some light in some of these fronts. Institutional adjustments may follow pending an internal "self-evaluation" meeting of IDIAP, to be held in the near future.

From these experiences, some points appear to be critical for consolidating efficient on-farm research operations within IDIAP. On the methodological front, it seems that diagnostic phase should be dimensioned (in terms of time and resources allocated to it) so as to make it instrumental to the experimentation phase. Also, research should start from the prevailing farming systems, trying to develop, for target crops within those systems, simple technological alternatives rather than full technological packages or complete alternative systems for the farmer. This responds to the type of time preference prevalent in the political and institutional environment in which IDIAP is integrated (i.e., results in three years are "preferred" to similar results in ten years).

Also, there is a need for the assimilation of these methodologies for on-farm research by new staff members who have joined IDIAP as these activities have expanded. This has multiplied the in-service training demands to a point where they can no longer be satisfied by the conventional training provided in international centers, bringing about the need for alternative mechanisms for in-country training.

Closely related to the first point, as the ad-hoc technical groups are institutionalized, covering more areas and involving more personnel, the problem managing of on-farm research activities becomes more complex. In particular, it requires increased technical supervision of new area programs, in order to capitalize on the methodological experiences obtained from the earlier ones. Also the emphasis on area specific work demands a decentralized style of management to effectively provide the logistic and financial support required by increased field operations. IDIAP has already moved in that direction, decentralizing management in three Regional Centers which are being organized and equipped. As on-farm research activities prove to be successful in terms of results, the institution may find itself in a position to attract more political attention and financing for investing and expanding appropriate experimental station research to be managed by those centers.

---

[17]Managing the Institutionalization of On-Farm Research within IDIAP. A Workshop for DirectiveStaff. IDIAP-CIMMYT, Volcan, Chiriqui, Panama, February 23-25, 1983.

Finally, from an organizational point of view, a close link is required between area-specific, on-farm research on the one hand and national crop projects and extension activities (IDIAP-MIDA) on the other. In particular, the role of extension in this process should be clearly defined, since more results will be forthcoming from the ongoing research operations. In the case of Panama, this will involve the National Direction of Technology Transfer of IDIAP, as well as MIDA's extension network.[18] A basic simple idea that may help on this definition could be to make the proper institutional arrangements for allowing IDIAP and MIDA extension units to directly conduct the verification and demonstration phase in the on-farm research programs. This could be done with assistance and eventually training from the on-farm researchers. Under this arrangement extensionist would become, working closely with farmers, familiar with the technological alternatives developed and tested; in our view, a necessary condition for an effective transfer independently of the communication methods used by extension.

As the central management of IDIAP moves to cope with these issues, the institution comes closer to realizing its full potential, both for the benefit of farmers and for society as a whole in Panama.

[18]Extension services are inserted in MIDA.

## REFERENCES


José Roman Arauz and Juan Carlos Martinez. "Desarrollando technología apropiada para el agricultor." Informe de Progreso del Programa de Caisan en Panama. Documento Preliminar IDIAP-CIMMYT, Panama y Mexico, Marzo, 1982.

Derek Byerlee, Michael Collinson, et al. "Planning Technologies Appropriate to Farmers-Concepts and Procedures." CIMMYT, Mexico, 1980.

Derek Byerlee, Larry Harrington, and Donald L. Winkelmann. "Farming Systems Research: Issues in Research Strategy and Technology Design." Paper invited for presentation at the Annual Meetings of the American Agricultural Economics, Logan, Utah, August 1-4, 1982.

Juan Carlos Martinez. "Desarrollando technología apropriada a las circunstancias del productor: El enfoque restringido de sistemas de producción." Working Paper, CIMMYT, Mexico, 1981.

Juan Carlos Martinez and Jose Roman Arauz. "Institutional Innovations in National Agricultural Research: On Farm Research in IDIAP, Panama." Working Draft. Partial translations for presentation in the Farming Systems Research Symposium, Kansas State University, November 21-23, 1982.

Juan Carlos Martinez and Gustavo Sain. "Evaluación económica de los programas de investigación en fincas del IDIAP: El caso del Programa de Caisan." Segundo Borrador, CIMMYT-IDIAP, Mexico, Noviembre, 1982.

# DEVELOPING TECHNOLOGY FOR SMALL FARMS; A CASE STUDY IN CENTRAL AMERICA

Luis A. Navarro[1]

## Introduction

This case study began in 1973 in Turrialba, within the Department of Crop Production of CATIE.[2] However, it has evolved as a regional and cooperative effort of different national institutes and CATIE, at field level and across all the countries of the Central American Isthmus.[3] It is operative in at least two specific geographical areas, with concentration of small farmers in each of the following countries: Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama.

Different aspects and comments related to the identification, design, implementation and evaluation of two research projects which conform the case study will be presented here.

Some comments will also be advanced in relation to remaining issues and implication for the future of the FSR approach used, as seen from the perspective of the participants in this case study.

This is not an official presentation for CATIE and all opinions are the responsibility of the author.

## Identification

In 1973 the personnel of the "Tropical Soils and Crops Department," of the recently founded CATIE, decided to focus their research activities on the study and technical improvement of the crop production systems used by the small farmers of the Central American region. This was in agreement with the priority given to the Small Farmers Sector by the different governments of the region during a consultation and diagnostic made across the Isthmus (4).

Small farmers, of less than 4 ha and with 4 to 35 ha, accounted for 76% and 18% of the Central American rural population respectively and half of the total 20 million peoples in the region. Their resources, low in quality, amounted to only one fourth of the total farm land and less than one fifth of total farm input expenditures, while their per capita income was under US $100 per year. They provided, however, two thirds of the total active rural labor force and over two thirds of the food crops produced value (excluding

---

[1]The author is grateful to R. Hawkins and C. Burgos for their contribution and comments for this paper.

[2]Appendix I has a discussion of the institution, CATIE. Appendix II presents the acronyms used in this paper.

[3]The results and observations presented in this paper are the joint product of CATIE and the following institutions: CENTA of El Salvador, DGTA of Nicaragua, ICTA of Guatemala, IDIAP of Panama, MAG of Costa Rica and PNIA of Honduras.

rice) for the region. Their participation in rice, perennial crops and livestock, which the region exports, amounted to 36%, 39% and 21% of their total production value respectively. Given the forecast for the next twenty years for population growth, economic expansion and energy costs, the "Small Farmers" will continue to be one of the most important social and economic sectors in the region.

The scientists at CATIE realized that they knew little about the crop production systems used by small farmers in the region and about methods to improve them technically. Appropriate literature was also scarce and scattered. Thus they were forced into a period of self training.

They initiated an experiment on plots at the Turrialba research station, in order to learn the management and test the productive potential of various crop systems. These were different cropping-patterns formed with corn, beans, cassava, rice and sweet potato, chosen to simulate some of those found on small farms.

Soon they acknowledged the need to approach the farmers directly to find what they were really doing, how and why. They visited farmers, and some experimental plots were installed on selected farms or on experimental fields of Agricultural Schools in different communities of Costa Rica.

The approach to the farmers was found crucial in understanding the present crop production systems, their objectives within the farms and their main limitations according to those objectives. A procedure for identifying and justifying appropriate lines of research was thus emerging. Later the experience was enriched through contacts and exchanges with IRRI in the Philippines and the "Puebla Project" in Mexico.

During this time, AID had also developed a keen interest for research strategies which could benefit small farmers. Thus in 1974, AID through ROCAP, its regional office, helped CATIE to hold in Turrialba a regional conference to explore the dynamics and possibilities for cropping systems research (1).

Following the conference, AID and CATIE formalized the CATIE/ROCAP Small Farmer Cropping Systems Project (SFCS), approved in 1975 with 1.6 million dollars in grant funds to CATIE and for implementation of the project during 1975-1979. This project would be used to reinforce the emerging ideas at CATIE and to attempt their implementation across the different countries of the region, through a strict interaction with personnel from the national research institutes.

In 1979 the CATIE/ROCAP Small Farm Production System Project (SFPS) was approved as a continuation and expansion of the SFCS, with a budget of 7.4 million dollars for implementation during 1979-1983 (12). This second project added responsibilities for research on the technology transfer and extrapolation aspects of the methodology and on animal and mixed crop-animal production systems.

## Design and Implementation

The design and implementation of the central projects in this case study evolved as a compromise between the basically bio-technical orientation of researchers and the strictly developmental orientation of AID/ROCAP.

## The Initial Project

The primary purpose of the SFCS project was to create a coordinated regional research approach for increasing the productivity and incomes of small farmers in Central America through improved cropping systems. The project would be implemented through research on cropping systems carried out in the fields of small farmers across the countries of the region and by multidisciplinary teams of national research professionals with the support of CATIE personnel.

To accomplish the objectives, CATIE had to reach agreement with every participating country on a program of activities including this collaboration with the national institutions. This implied an expectation for counterpart personnel and research resources from every country. Furthermore, the in-country research was to include: 1) design and implementation of surveys of small farmer characteristics and their cropping systems, 2) use of this material to compile profiles of the target areas, farmers and their farming practices, 3) design and implementation of on-farm research to increase small farmers' yield through the improvement of their cropping system performance, 4) development of ten area-specific technical recommendations by the end of the project.

Even though the project gave a sketch of a methodology, this was to be developed during the project. The training activities were also crucial for the personnel hired specifically for the project as well as for the national participants.

The personnel hired for the project included one Resident Agronomist to coordinate the activities in each participating country and five specialists (Biometrics, Entomology, Soil Management, Horticulture and Agricultural Economics) to act as a back-up team from Turrialba.

Agreements were signed almost immediately (1975) with the governments of Costa Rica, Nicaragua and Honduras. The work in El Salvador and Guatemala, however, did not begin until 1977 and 1978 respectively even though the agreements were signed in 1976 (10).

The resource limitations at the national institution level were reflected in the instability of the national teams and counterpart research resources provision during the project implementation. Political tensions in El Salvador and Nicaragua were also forces which produced slowdowns in the work.

However, the progress obtained through the work in the different countries plus the previous and compatible experience of counterpart institutions such as CENTA in El Salvador and ICTA in Guatemala clearly enriched the methodology and the whole approach. The acceptance of this approach by the counterpart institutions was clear and some field results were also promising.

General comparison indexes between some on-farm research results and the farmers' check cropping systems, obtained in different areas, are shown as examples in Tables 1, 2, 3 and 4 (11). These results were obtained under the direct observation, council and participation of farmers and farm labor. The number of farms on which different experiments were replicated varied from two to ten depending on the area. In most cases the performance indexes for the

Table 1. Location and cropping pattern characteristics of farm level tested modification to cropping systems practiced by small farmers of different areas in Central America (CATIE 1978-1979)

| Geographic Area | | Cropping Pattern | | |
|---|---|---|---|---|
| Country – Location | Gen. Character. | Studied | Check | New Variety? |
| COSTA RICA | | | | |
| Guácimo-Pococí | H | cassava<br>corn beans | cassava<br>corn | No<br>Yes, Yes |
| Guácimo-Pococí | H | corn corn | same | Yes, Yes |
| Pérez Zeledón | H+S | corn beans | same | Yes, No |
| Pérez Zeledón | H+S | corn corn<br>beans beans | corn beans<br>beans | Yes, Yes<br>No, No |
| HONDURAS | | | | |
| Yojoa | S+H | corn corn<br>pipián pipián** | corn corn<br>squash squash | Yes, Yes<br>N.C., N.C.* |
| Yojoa | S+H | corn corn<br>cowpea | corn corn | Yes, Yes<br>N.C. |
| Yojoa | S+H | corn cowpea<br>rice | rice beans | Yes, N.C.<br>Yes |
| NIGARAGUA | | | | |
| Samulalí | H+S | corn<br>beans | same | Yes,<br>Yes |
| Samulalí | H+S | sorghum sorghum<br>beans beans | beans beans | N.C., N.C.<br>Yes, Yes |
| SALVADOR | | | | |
| Chalatenango | S | corn<br>sorghum | same | Yes,<br>No |

H = humid; S = dry with a short rainy period; S+H + dry period tends to be longer than the humid period; H+S = humid period tends to be longer than the dry period.

* N.C. + New crop as an addition or change within the cropping pattern.
* Pipián is a type of squash (Cucurbita spp.) consumed as an immature fruit.

Table 2. Changes in some technical economic indexes as a result of farm level evaluated modifications to cropping systems practiced by small farmers in different areas of Central America (CATIE 1978-1979).

| Geographic area "cropping pattern" | Labor | Inputs | Total Cost (d) | | Net Income | Family Income | |
|---|---|---|---|---|---|---|---|
| | Man day/ha %Δ | CA$/ha (b) %Δ | CA$/ha %Δ | CA$/ha | CA$/ha %Δ | CA$/ha %Δ | CA$/ha |
| COSTA RICA | | | | | | | |
| Guácimo-Pococí | | | | | | | |
| Cassava + (Corn//Beans) (e) | 72.2 | 172.8 | 100.1 | 1305.7 | 181.9 | 140.6 | 2494 |
| Corn – Corn | 30.7 | 94.7 | 53.2 | 904.1 | 19.1 | 25.3 | 898 |
| Pérez Zeledón | | | | | | | |
| Corn-Beans | 15.0 | 269.0 | 51.0 | 673.3 | 403.0 | 130.0 | 1255 |
| (Corn+Beans) – (Corn+Beans) | 57.7 | 553.8 | 115.5 | 1043.9 | -143.8 (-43.5) (e) | -40.9 (+9.35) | 461 |
| HONDURAS | | | | | | | |
| Yojoa | | | | | | | |
| (Corn+Pipiá) + (Corn+Pipián) (a) | -1.0 | 83.0 | 23.0 | 369 | 152.0 | 62.0 | 605 |
| (Corn# Cowpea) - Corn | 17.0 | 42.9 | 26.0 | 351 | 19.3 | 19.0 | 672 |
| (Corn+Rice) - Cowpea | 8.4 | 27.0 | 15.0 | 395.8 | -26.0 (+273.0) | -2.0 (+96.0) | 328 |
| NICARAGUA | | | | | | | |
| Samulalí | | | | | | | |
| (Corn# Beans) | 28.1 | 22.2 | 24.1 | 576.4 | 62.9 | 38.5 | 668 |
| Sorghum + (Beans//Beans) | 22.9 | -1.5 | 10.1 | 586 | 5002.0 | 126.0 | 713 |
| EL SALVADOR | | | | | | | |
| Chalaterango | | | | | | | |
| Corn# Sorghum | 16.4 | 105.3 | 37.2 | 599.4 | 62.7 | 36.5 | 805 |

(a) Pipian is a type of squash (Cucurbita spp.) consumed as an immature fruit.
(b) 1CA$ (Peso Centroamericano) = 1US$ (United States Dollar); %Δ = percentage of increment in relation to the farmer's check cropping system performance.
(c) All comparisons are based on the worst on-farm experimental results or 70% of experimental averages. Figures in parentheses show experimental averages.
(d) Total cost includes all factors including land, management and use of capital.
(e) + is in the ground with; - is followed by; # in relay with; // followed shortly after by.

Table 3. Technical economic efficiency indexes for some farm level evaluated modifications to cropping systems practiced by small farmers in different areas of Central America (CATIE 1978-1979).

| **Geographic area "cropping pattern"** | **Net Return Over Additional Investment CA$/1US$ (b)** | **Return to** | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cash Input Costs | | Labor | | Land | |
| | | CA$/1US$ | %Δ (c) | CA$/man day | %Δ | CA$/ha | %Δ |
| COSTA RICA | | | | | | | |
| Guácimo-Pococí | 1.7 | 2.95 | 9.7 | 20.6 | 49.3 | 1695 | 112 |
| Cassava + (Corn//Beans) (e) | .2 | .60 | -38.9 | 10.0 | - 4.6 | 448 | 17 |
| Corn – Corn | | | | | | | |
| Pérez Zeledón | | | | | | | |
| Corn - Beans | 2.8 | 3.60 | 36.0 | 11.7 | 117.0 | 854 | 307 |
| (Corn+Beans) + (Corn+Beans) | -.3 | -.17 | -121.0 | 3.0 | - 66.6 | -121 | -130 |
| | | | | | | (253) | (-38) |
| HONDURAS | | | | | | | |
| Yojoa | | | | | | | |
| (Corn+Pipian) + (Corn+Pipian) (a) | 3.2 | 2.7 | 38.0 | 3.5 | 155.0 | 406 | 127 |
| (Corn # Cowpea) - Corn | 1.5 | 4.9 | -17.0 | 6.8 | 2.0 | 702 | 18 |
| (Corn+Rice) = Cowpea | - .5 | .6 | - 4.0 | .7 | - 29.0 | 115.2 | -18 |
| | (+5.9) (d) | | (+193) | (+3.6) | (+246) | (+444) | (+215) |
| NICARAGUA | | | | | | | |
| Samulalí | | | | | | | |
| (Corn # Beans) | 1.0 | 2.6 | 17.0 | 4.1 | 4.0 | 310.0 | 54 |
| Sorghum + (Beans//Beans) | 6.3 | .7 | 450.0 | 2.7 | 400.0 | 378.0 | 908 |
| EL SALVADOR | | | | | | | |
| Chalaterango | | | | | | | |
| Corn # Sorghum | 1.0 | 2.0 | - 20.7 | 7.4 | 19.5 | 474.0 | 51 |

(a) Pipian is a type of squash (Cucurbita spp.) as an immature fruit.
(b) 1CA$ (Peso Centroamericano) = 1US$ (United Satates dollar).
(c) %Δpercentage of increment in relation to the farmer's check cropping system performance.
(d) All comparison s are based on worst on farm experimental results or 70% of experimental averages. Figures in percentages show experimental averages.
(e) + is in the ground with; - - is followed by; # in relay with; //followed shortly after by.

Table 4. Effect on per ha production and productivity of several farm level evaluated modifications to cropping systems practiced by small farmers or different areas of Central America (CATIE 1978-1979).

| Georgraphic Area | | Cropping Pattern* | | | |
|---|---|---|---|---|---|
| Country-Location | Gen Charact. | Modified | | Farmers Check | |
| COSTA RICA | | | | | |
| Guácimo-Pococí | H | Casv. 30.5-32 T<br>Corn 1.4-1.6 T<br>B .9-1.1 T | | Casv. 10-12 T<br>Corn 1-1.8 T | |
| Guácimo-Pococí | H | Corn 3-4.3 T | Corn 3.2-4.5 T | Corn 1.8-2.6 T | Corn 1.0-1.8 T |
| Pérez Zeledón | H→S | Corn 4.7-6.6 T | B .8-1.2 T | Corn 1.4-2.2 T | B .4-.6 T |
| Pérez Zeledón | H→ | Corn 2.2-3.1 T<br>B .1-.2 T | Corn 1.3-1.9 T<br>B .1-.2 T | Corn .9-2.4 T<br>B 0-.15 T | B .3-.5 T |
| HONDURAS | | | | | |
| Yojoa | S→H | Corn 2.2.5 T<br>P 3.5-5 TU | Corn 1-1.5 T<br>P 3.1-4.4 TU | Corn .8-1 T<br>SQ .9-1.1 TU | Corn .3-.8 T<br>SQ .8-1 TU |
| Yojoa | S→H | Corn 2.5 3 T<br>CP .5-.8 T | Corn 1.5-2 T | Corn 1.0-2.5 T | Corn .4-1.8 T |
| Yojoa | S→H | Corn 1.0-1.5 T<br>R 1.0-1.5 T | CP .4-.8 T | R .5-1 T | B 0-.5 T |
| NICARAGUA | | | | | |
| Samulalí | H→S | Corn 4-5.2 T<br>B .8-1 T | | Corn 2-3 T<br>B .5-.6 T | |
| Samulalí | H→S | S 1.1-1.6 T<br>B .9-1.3 T | SR .6-.8 T<br>B .6-.8 T | B .8-1 T | B .6-1 T |
| EL SALVADOR | | | | | |
| Chalatenango | S | Corn 3-3.5 T<br>S 2.5-3 T | | Corn 1.8-2 T<br>S 1.1-1.5 T | |

* Symbols: Casv. = cassava; Corn = corn; B = beans; P = pipián; SQ = squash; R = rice; CP = cowpea; SR = sorghum ratoon; T= metric ton; TU = thousand units.

H = humid; S = dry with a short rainy period; S→H = dry period tends to be longer than the humid period; H→S = humid period tends to be longer than the dry period.

check cropping system include data from more farmers than those directly involved in the experiments.

The SFCS project advancement stopped just short of verification studies. One attempt was made on 40 small farms of Esteli, Nicaragua, where one of the technical recommendations developed in Samulali was "verified" even during the revolution in 1979-1979. Furthermore, in 1980 the new government took interest in disseminating that technical option in the Matagalpa and Esteli areas through PROCAMPO, the new extension institution. However, priorities and plans were later changed.

Based on different progress evaluations of the SFCS project, a new four-year project was designed to follow up and expand on the initial one.

The Second Project

The new regional project was the Small Farms Production Systems (SFPS) project, to be implemented through the same type of interactive work with national institutions (12).

Its design included:

1. Research for the development of improved technical options for small farmers of target areas and for their:

   a. Crop production systems (ten).

   b. Animal production systems, particularly those which include "small species" (six).

   c. Mixed crops-animal production systems (three).

2. Research on methodologies for the "extrapolation" of area-specific research results to analogous situations.

3. Research on technology-transference.

4. Training of national personnel in methodology and other aspects related to the advancement of the project.

Thus the SFPS project would allow for a better definition of the research methodology as part of the process of technology development within a given area, and for addressing the two related key issues of site-specificity and the research-extension interphase. Furthermore, it would allow expansion of the project scope from cropping systems to include animal production systems and mixed crop-animal production systems within the small farm, as possible steps toward a "whole farm approach." In what follows of this presentation, the focus will continue to be on the crops component of the project.

Additional resources were provided to include activities in Panama and for reinforcing the team with appropriate personnel for the technology transfer activities.

The implementation of the SFPS project has not been without problems. Some are similar to those of the previous SFCS project. Others include slowdowns of

the research on: "extrapolation" because of personnel changes within the project team, and "technology transfer" because its allocated budget was delayed up to October of 1981. Today, however, the project is being implemented in all its components and in 16 different target areas across the six countries, sampling the main ecological situations of the Isthmus (7).

The interaction among the research personnel from CATIE and the national research institute with the extension personnel at field level within the different target areas is being motivated and becoming stronger. The interaction among crop production and animal production scientists within and outside CATIE is also evolving.[4]

Several technical recommendations in crop production as well as in animal production have been developed and evaluated through on-farm research. Some of those in crop production are being "verified" (or "validated") under the strict management of at least 30 farmers each. These include simple changes in the following cropping systems and areas: potato-(maize+beans) in La Esperanza, Honduras; maize-beans and maize/sorghum in Comayagua, Honduras; maize/sorghum in Tejutla and San Miguel in El Salvador; maize-beans in Matagalpa, Nicaragua; maize-maize and maize-cassava[5] in Guapiles, Costa Rica (6). In some cases the first harvest has already taken place and results are very promising. As expected, the technology has shown to be feasible in terms of the availability of resources and management capability of farmers. Measured yield increases in maize, under those situations, has been at least 60% with less than proportional increases in cost, thus improving the income possibilities for farmers under their present circumstances.

Several mixed crop production systems of importance on small farms have been identified, and joint research efforts of animal production and crop production scientists have begun for improving their performance in areas of El Salvador, Honduras, Nicaragua and Costa Rica. These production systems include the widely spread maize/sorghum cropping pattern associated with dual-purpose cattle production in the SAT[6] and the use of plantain and other crops residues as feed for pigs in the LHT[7] of the region.

Some technical changes developed to improve the maize/sorghum cropping system in San Miguel of El Salvador are being tested during 1982 on over 70 small farms of 35 different and seemingly analogous sites of the SAT in El Salvador, Guatemala, Honduras and Nicaragua. This effort is part of the research on "extrapolation" which began by considering the location of the maize/sorghum cropping system in the region and the climatic and soil information of these locations to assess on the possibilities for extrapolating a given technology.

---

[4]A Symposium on Mixed Crop-Animal Production Systems was held in CATIE with the participation of Winrock Int. and CARDI in August 1982 (5).

[5]- is followed by; / in relay with; + in association with.

[6]SAT = Semi Arid Tropic.

[7]LHT = Low Humid Tropic.

The "verification" trials, mentioned above, form part of the research on “technology transfer."

During August of 1982 the project implementation, only in its crops component, included the direct participation of a) 20 professionals from CATIE, b) at least 75 professionals from national institutions, c) more than 40 persons, from CATIE and the participant institutions, involved in administrative and field back up and d) 60 field workers. During the same time, some type of activity related to the project was carried on over 400 small farms, with different degrees of participation from the farmers themselves and across the 6 countries of the Isthmus (7). Field days and meetings of different kinds helped to present the project activities and results to more farmers and technicians in the different target areas.

Evaluation

Different evaluations have been scheduled during this case study. They have been implemented through teams of knowledgeable people in FSR, who visit Turrialba and the different sites and participating institutions across the region, to survey the present state of implementation and repercussion of the project in comparison to what was expected. Usually these teams are formed and hired directly by ROCAP/AID in consultation with CATIE. Other cases of evaluation have been in the form of consultant services hired directly from selected scientists by CATIE.

Evaluations have been favorable in terms of opinion and direct contributions to the project development. Many personalities involved in these evaluations are well known to the FSR practitioners. One of the best documented evaluations is the AID Project Impact Evaluation Report No. 14, made in December of 1980 and reported as "Central America: Small-Farmer Cropping Systems" (10).

A final type of evaluation is that made by the personnel directly involved in the project. The following is an attempt to review the methodology, which emerged from the project, to evaluate its state of evolution and possible repercussions, as seen by the participants in this case study.

The Methodology and its Background

The variety of situations in which the project has been implemented shows that the FSR approach is useful as a general framework. Within than, however, a strategic adjustment to the set of circumstances in which the approach is implemented should occur. Such circumstances are a combination of: a) quantity and quality of research resources, b) degree of autonomy of the participating institutions from political forces, c) degree of existing coordination and interaction among agricultural institutions, particularly research and extension, d) available information about resources, accessibility and other production characteristics of target areas and e) particular characteristics of target area and populations.

Thus, the methodology which emerged from this case study contains several phases and details. However, they might not be all necessary or implementable in certain situations. Even the order or timing for implementing different steps may require a particular strategy.

To attempt an improvement of present cropping systems, or crop production systems, it is first necessary to know those cropping systems as well as the existing conditions to guide the work. Those conditions are the farmer's current resource endowment (quantity and quality), his goals and purposes, as well as his knowledge and management capabilities (what they are doing, how they are doing it and why they are doing it).

Existing conditions at the small farm level, which determine most of the cropping system characteristics, are consequences of the ecological as well as socio-economic environment in which small farmers work.

The local ecological environment determines most of the physical and biotic characteristics of the resources handled by farmers. These characteristics force certain technological adjustments in the cropping systems as well as the adjustments and priority changes in farmers' goals. For example, in areas of erratic rainfall (i.e. the north of El Salvador), small farmers have developed cropping systems based mainly on corn and sorghum, mostly as association or relay crops. In case of insufficient rain for corn, (the preferred crop), they will at least harvest sorghum, diminishing the implied risks for their subsistence. In areas where there are possibilities of excessive rain, farmers prefer associations based on rice and corn. Even the localization and arrangement of those crops within the farm are accounted for by the amount of water available in the soil.

The influence of society is shown mainly in the poor geographic location and income-bracket of small farmers. They have been relegated there by the general type of agricultural development and its present structure, based mainly on large scale, capital intensive, export-type production. However, society may also provide incentives and supporting guidance to small farmers. These may come as improvement to their products market (marketing institutions), reinforcement of their resource endowment (credit, subsidy, input and machine service institutions) and reinforcement of their knowledge (research and extension-type institutions).

## Strategy

The strategy to be described is an attempt to distribute the basic FSR stages throughout different working phases. These phases are necessary to allow the proper and integrated work of a multidisciplinary research team subject to the usual personnel and budget restrictions at the national level. furthermore, it attempts to allow and to promote the complementary action among agricultural institutions.

Simply stated, the phases in the strategy to implement this type of research in specific areas are as follows:

### Initial Activities

1. Area selection, which is based on criteria such as national priorities, area potential for improvement, and possibilities for extrapolating results to and from other areas and farmers (being representative of important ecological and/or socio-economic environments). Many times, however, the target area is predetermined to the institution.

2. Area delimitation and general characterization (technical and socioeconomic). This is based first on background information complemented by reconnaissance visits to the area or "sondeos" by a team. Such information should allow delimitation of relatively homogenous units (in terms of climate, soil, farm resources, etc.) within the study area. These units should be used for surveys, experimental design and interpolation of results. Each of the selected units should now be further characterized through informal or formal surveys and/or measurement procedures. Methods used will vary depending on the completeness of existing information and available research resources. The purpose is to identify the relevant crops and cropping systems, the principal constraints on production and productivity, and other criteria for evaluating research focus, progress and results. An attempt should be made here to quickly identify "obvious" technological changes which could be introduced and adopted without lengthy testing and evaluations.

Yearly Activities

3. Team analysis of the current technical and socio-economic information about the area, farms, farmers and selected cropping systems. Appraisal of the technical knowledge available to the research team in order to:

   a. Design and/or review the design of cropping systems modified for improvement. This should pay attention to cropping pattern, crop components and/or different elements of management.

   b. Classification of resulting designs according to the team expectation and knowledge of their performance. Resulting groups could: i) need further exploration or support research; ii) need agronomic and/or economic evaluation; iii) need validation[8] under farmer management; iv) be ready for diffusion.

4. Planning of the field work for the year. All phases should be timed to allow the beginning of the field work in accordance with the agricultural season in the area. Planning should define type, number, experimental design and location of experiments. It should also identify and plan complementary studies for the area characterization and special studies. All activities should be guided by requirements and availability of research resources. The majority of field work should be located on farms and include the farmers' participation even in planning. Work to be implemented could consist of: i) work of an exploratory nature e.g. variety trials; ii) testing of newly designed modifications to cropping systems; iii) support research experiments to solve doubts in design; iv) agronomic and/or socio-economic evaluations of previously observed designs; v) validation under direct farmers' management of previously and positively evaluated technology; vi) completion, as needed, of area, farm and cropping system characterization, especially with regard to their dynamic characteristics needing periodic observations; vii) special studies of an agronomic, and/or socioeconomic nature. Efforts to report and transfer already validated

---

[8]Validation or verification trials correspond to the farmers' testing of a technology with total control by the farmers themselves on their farms.

technologies to appropriate institutions for their diffusion and/or implementation should also be planned. These include a definition of the timing, procedures and the interaction with other institutions in the area. The planning should be a complete team effort so that most of the work and responsibilities are understood and accepted as appropriate by each member.

5. Implementation of planned field work. This should include at least a mid-year revision of progress to include and rationalize necessary previous and future adjustment to field work in the year.

6. Team analysis of field work results and updating of the technical and socio-economic information about the area, farms, farmers, and selected cropping systems. With this the team is ready to start the next year's work as in phase C).

In the case of coordination of action with other institutions, phases 3 through 6 are mostly the responsibility of the research team. Phases 1 and 2 could be implemented with a strong participation from the team but with great responsibility from other appropriate institutions. Other institutions dealing with extension and credit should also have leadership in the diffusion and implementation of produced (validated) improved technologies mentioned in phases 3 and 4.

The need for a multidisciplinary team approach is implicit in the type of research and methodology. The different teams formed during this case study have included specialists in agronomy, plant protection, social sciences and data processing. These teams are considered multidisciplinary with the need for at least partial interdisciplinary actions during the work. It is intended that no particular discipline or group of disciplines be solely responsible for any major portion of the work. However, it has been clearly seen that there is a need for letting individual scientists have certain latitude for freer action within their discipline which should be justified in terms of the whole team's objectives. This is reasonable since the whole team's effect is composed of contributions by individual disciplines and the results of their interactions.

The work requires a change in attitude from each scientist who has been trained as a specialist.

Implications of the Methodology in its Present State

Evolving from the original idea of focusing research, possibly in a more traditional and controlled manner, on the cropping systems used by the small farmers, the final methodology in the case study considers and explicitly positions the research within:

1. The whole process of technology development for a given area and in contact with the beneficiary farmers on their own farms.

2. The whole set of circumstances of the farms in which the technology should operate and produce tangible benefits to farmers and society.

However, it is still centered around the researcher and extensionist responsibilities within the technology development process. The participation and influence of other agricultural support institutions is usually considered as exogenous.

Within research itself, it is centered around an "adaptive" type of research, even though its ties with and motivation for a "support" type of research are constantly evolving.

At the farm level it still focuses attention on particular components of the whole farm (particular cropping systems, animal production systems or mixed crop-animal production systems). Even though it requires a careful consideration of the interaction of the target production system with the remains of the farm, it is short of being a "whole farm approach" or "FSR on the large" as is conceptually proposed by many.

However, even in its present stage of evolution, the methodology has a series of repercussions and requirements. The participant researcher sees his or her traditional scope of work increased in two dimensions: 1) as part of the whole technology development process and 2) as part of a production system within a farm and all its circumstances. Even though researchers realize that this fact puts their work in much better perspective, they need guidance to understand that it is neither required nor convenient that the researcher become responsible for everything within this amplified scope. Researchers should be motivated to accept and search for the support and complementary work of other participant disciplines and institutions to make the whole approach more efficient. The principal motivation should be for the use of existing technological knowledge and documented research results, whenever possible and appropriate. The interaction with extension personnel is useful during the area selection and diagnostic stage, as well as in selecting collaborating farmers and in interacting with them during the on-farm evaluation or validation trials and the extension phase. Interaction with technicians from other institutions should also be motivated when appropriate.

Furthermore, when the participation of extensionists or technicians from other institutions are not made explicit or they are not advised when some activities related to their field and work area are necessary, some misunderstanding might arise. The most common are the apparent duplication of activities or interferences which are not well thought out from the institutional organization point of view and are detrimental for motivating any desired collaboration. To avoid this, a continuous effort of communication with other institutions working in the area might be needed.

The previous observations tend to suggest that efforts similar to the case study should be proposed as temporary and geared to put in proper perspective, motivate and organize the needed interactive and cooperative work among the different institutions with responsibilities in technology development. This promises to benefit their individual as well as their joint contribution to development. The effect of this might also motivate appropriate legislation and resource allocation to make this permanent.

Many observers of the approach in its present state tend to point out its apparent greater requirements, in resource quantity as well as duality and organization, than is presently available. However, these requirements also exist under the more traditional approaches, and it is not clear yet that those observations of relatively high cost through provision of new resources are true. Possibly the foremost requirement is a reorientation and reorganization of existing resources in the different institutions to allow their effective interaction. It does not even require changes in their present broad objectives and responsibilities for cooperative work; but, it does require acceptance of these as appropriate and desirable for their own effective work.

Clearly, however, the approach requires motivation and special training for all new participating personnel. To diminish this need in the future, such motivation, orientation and training should be incorporated as part of the normal professional preparation before graduation.

Crucial elements in training include background and operation of the methodology as well as team organization and leadership. A complementary element found at fault, in most situations, relates to the capability to identify and properly design projects which could be proposed for financing by the government or other available sources.

The regional character of the case study has shown that the whole approach can be greatly benefited by a networking of the teams operating in different areas and across countries. This provides for cross feeding of information, motivation and more attractive possibilities for training in benefit of over-all efficiency.

Repercussions of the Case Study

The repercussions of this case study have been analyzed at the CATIE, national institution and the farmer levels.

The repercussions in CATIE have been especially important within the Crop Production Department. The CPD centers its work on research and training for the development of production technology in important cropping systems on small farms of the region. This is done by promoting, stimulating, and participating in the formation, training, work and support of national multidisciplinary technology development teams. It is achieved by the interaction of two structural elements: 1) outreach for direct support to research institutions and 2) activities at CATIE, such as supportive research, methodology development and training, in support of the outreach. The first element acts and interacts with national institutions across the countries of the region. An Outreach Coordinator has the basic responsibility of providing two-way communication between national research programs and the cropping systems research team and support components of the CPD. The second element provides a linkage of research across countries and ecological situations within the mandate region. This is achieved by lending scientific support to country teams in terms of genetic material, research methods, specific component technology, documentation, laboratory, data processing and biometrics services. In addition, a specific support research team was formed to back up national teams working mainly within the SAT and LHT of the Isthmus. Training personnel and activities also support the network of research sites by providing task-specific training as well as in the methodology for interdisciplinary research with farmers' participation. Resources for the reorganization of the CPD have been provided since 1978 by different agreements and projects designed to allow the complimentarity and organization of the different activities of the CPD, under the approach developed during the case study. Financing has been provided by AID, EEC, GTZ, IDRC and IFAD.

At the country level, every research institution is aware of the approach promoted by CATIE and is utilizing it to different degrees. In every country at least one research institution is participating as part of the regional effort presented in this case study. In many cases, moreover, there are similar efforts which have begun in other areas of the country and usually in interaction with other international research support or financing institutions reinforcing the use of the approach in the region. The requirement for training in the use of

the approach and in the identification and design of projects using it have also increased at country level. It is anticipated that this support will be needed for several years.

At farmer level, even though the case study has not entered completely into the extension phase, there are some direct repercussions. In all the target areas many farmers have provided direct cooperation to the technicians and they have also received some technical feedback, mostly in an informal manner and in aspects beyond the work specific to the case. Many of them have received inputs, for plots as large as 1000 $m^2$ and 0.7 ha[9] during verification trials. In some of the target areas, such as Matagalpa in Nicaragua, some technical elements have been picked up by several farmers even from evaluation plots without any transference effort. In other areas farmers seem to be increasing their confidence in technical personnel at least in accepting to interact with them.

The direct interaction between researchers and extensionists at the area level is benefiting both groups and the farmers. However, there is much to do yet to reinforce the research-extension transition and extension phase in the approach within the case study. In the same way, there are still needs for developing specific and simpler procedures, particularly for the "grey areas" which coincide with the transitions among different phases of the approach and with the interaction among institutions. All these will be crucial in relation to the organization among institutions and political commitment to a continuous and efficient technological development effort, given their resource endowment.

So far the methodological evolution and state of development of the research approach described is very promising. However, the awareness and willingness of the technicians involved in this type of work at field level might become as important as the approach itself for closing the time lag between an initial investment in research for a given area and its measurable impact at farm level. This implies that even though temporary, efforts such as this case study promise permanent benefit to the agricultural research institutes and farmers of the region.

---

[9]0.7 ha = 1 manzana, land measurement unit used in Central America.

# APPENDIX I

## THE INSTITUTION

CATIE is the "Tropical Agricultural Research and Training Center" located in Turrialba, Costa Rica. Its mandate includes research, training and technical cooperation in crop production, animal production and forestry with focus on the Central American and Caribbean regions.

CATIE was founded in 1973 as an association between IICA, the specialized agricultural body within the OAS, and the Government of Costa Rica. Guatemala, Honduras, Nicaragua and Panama have also become partners in the association while the memberships of El Salvador and Dominican Republic are in process.

The priority for CATIE's orientation and focus on the "Small Farm Sector" of the region was identified by the member countries in 1973 (2).

CATIE operates with a staff of 80 professionals in different fields of agriculture (half of them expatriate) and a budget of ten million dollars per year. Most of the budget is accounted for by specific agreements and projects financed by AID, DDA, EEC, IBM, IDB, IDRC, IFAD, GTZ, ODA, UNU, Kellog Foundation and the Government of Holland. IICA and the member governments provide the core budget (8).

At its headquarters in Turrialba, CATIE houses the oldest graduate school and one of the principal libraries in agriculture for Latin America.

CATIE develops most of its activities out of Turrialba at country level and in strict interaction with the different national institutes.

Three research departments (Crop Production, Animal Husbandry, Natural Renewable Resources) and one support department (Resources for Research and Training) allow the present outreach work of CATIE.

# APPENDIX II
# ACRONYMS

| | |
|---|---|
| AID | Agency for International Development, United States |
| CATIE | Centro Agronómico Tropical de Investigación y Enseñanza (Tropical Agricultural Research and Training Center) |
| CENTA | Centro Nacional de Tecnología Agrícola (National Center for Agricultural Technology), El Salvador |
| CPD | Crop Production Department |
| DDA | Swiss Program of Cooperation for Development |
| DGTA | Dirección General de Técnicas Agropecuarias (General Direction of Farming Technics), Nicaragua |
| EEC | European Economic Community |
| FSR | Farming Systems Research |
| GTZ | Gesellschaft für Technische Zusammenarbeit (Agency for Technical Cooperation), Germany |
| IBM | International Business Machines |
| ICTA | Instituto de Ciencia y Tecnología Agropecuaria (Institute for Agricultural Sciences and Technology), Guatemala |
| IDB | International Development Bank |
| IDIAP | Instituto de Investigaciones Agropecuarias de Panama (Agricultural Research Institute of Panama), Panama |
| IDRC | International Development Research Centre, Canada |
| IFAD | International Fund for Agricultural Development |
| IICA | Instituto Interamericano de Cooperación Agrícola (Interamerican Institute for Agricultural Cooperation) |
| IRRI | International Rice Research Institute |
| LHT | Low Humid Tropic |
| MAG | Ministerio de Agricultura y Ganaderia (Ministry of Agriculture and Livestock), Costa Rica |
| PROCAMPO | Programas Campesinos (Peasant Programas), Nicaragua |
| OAS | Organization of American States |
| ODA | Overseas Development Administration, United Kingdom |

| | |
|---|---|
| PNIA | Programa Nacional de Investigación Agropecuaria (National Program for Agricultural Research), Honduras |
| ROCAP | Regional Office for Central American Programs |
| SAT | Semi Arid Tropic |
| SFCS | Small Farmer Cropping Systems |
| SFPS | Small Farm Production Systems |
| UK | United Kingdom |
| UNU | United Nations University |

## REFERENCES


Centro Agronómico Tropical de Investigación y Enseñanza. Conferencia sobre Sistemas de Producción Agrícola para el Trópico; Informe Final. CATIE, Turrialba, Costa Rica, 1974. 240 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. El nuevo enfoque del CATIE para el desarrollo agrícola y rural de Centroamérica y Panamá; su político, organización y principios de operación. CATIE, Turrialba, Costa Rica, 1976. 17 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Programa de Cultivos Anuales. Segundo Informe Anual 1980-1981, Sistemas de Producción para Fincas Pequeñas. CATIE, Turrialba, Costa Rica, 1981. 306 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Research and training for developing crop production technology of small farms in CATIE's mandate region. CATIE, Turrialba, Costa Rica, 1981. 36 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Research on Crop-Animal Systems. Proceedings of a Workshop CATIE-CARDI-Winrock International, Turrialba, Costa Rica, 1982. 77 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Departamento de Producción Vegetal. Validación/transferencia: informe de avance 1° de diciembre de 1981 al 31 mayo 1982. CATIE, Turrialba, Costa Rica, 1982. 40 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Departamento de Producción Vegetal. Informe trimestral 1° de junio al 31 de agosto 1982. CATIE, Turrialba, Costa Rica, 1982. 131 pp.

Centro Agronómico Tropical de Investigación y Enseñanza. Proyecto de Programa-Presupuesto 1983. CATIE, Turrialba, Costa Rica, 1982. 127 pp.

Crawford, P. R. and Barclay Junior, A. H. AID experience in agricultural research: a review of project evaluations. U.S. Agency for International Development. Program Evaluation Discussion Paper, No. 13, 1982. 257 pp.

Hobgood, H. H., et al. Central America: small farmer cropping systems. U.S. Agency for International Development/CATIE/ROCAP. Project Impact Evaluation Report, No. 14, 1980. p. irr.

Navarro, L. CATIE's Small Farmers Oriented Agricultural Research Effort in the Central American Isthmus. In: FAO consultation meeting on Natural Resources on Small Farms in the Caribbean Region, Kingston, Jamaica 1980, 22 pp.

Regional Office for Central American Programs. Agricultural Research and Information System and Small Farm Production Systems. Washington, D.C., Department of State Agency for International Development, (Projects Number 596-0048 and 596-0083); 1979. p. irr.

# LINKING FARMING SYSTEMS RESEARCH AND EXTENSION TO THE FARMER - THE PHILIPPINE EXPERIENCE

Edgardo C. Quisumbing[1]

## Background

Even before the Masagana programs in rice and corn production were launched in the early 70's, the Philippines had been pursuing the development of the agricultural sector through the implementation of commodity-oriented production programs. Such strategy was necessary, for it enabled the country to concentrate its limited financial and manpower resources on priority commodities. Many programs focusing on the production of rice, corn, sugarcane, coconut and livestock were implemented. The most massive of these is the Masagana 99 rice production program, which was also known as the "program for survival." It was launched after a killer flood devastated our rice production area in the north and a drought hit us in the south.

The results of the Masagana 99 program are now legend. It brought the country to rice self-sufficiency and made it a rice-exporting country in just a few years. However, the impact of the oil crisis has resulted in increased prices of farm inputs and has seriously affected the incomes of the rice farmers. This situation, plus the high risks inherent in agricultural enterprises as a result of the vagaries of the weather, prompted the Ministry of Agriculture to review the commodity-oriented approach to agricultural development.

It became apparent that in order to minimize risks and at the same time increase the incomes of our farmers, the whole farm should be considered as a resource, and production programs focused at utilizing the entire farm instead of just a single commodity of the farm should be implemented. Thus was born the concept of farming systems, which is basically the utilization of the entire farm for the maximum benefit of the farmer. It could involve the production of several crops together or in sequence, the production of livestock or fish to utilize farm by-products and any post-harvest or post-production activity which would be necessary to add value to the farm's production. The farming systems approach, by virtue of its orientation towards optimizing farm productivity and profit, will have more flexibility in dealing simultaneously with several commodities.[2] As a matter of fact, this approach would probably be more fitted to areas which are producing a wide range of agricultural commodities, i.e., crops and livestock. Furthermore, this approach necessitates that supervision be focused on farms rather than only on the crop or livestock of the farmer.

## Farming Systems Program in the Philippines

Farming systems research and extension activities in the Philippines are being implemented through various programs and projects of the Ministry of

---

[1]Deputy Executive Director, National Food and Agriculture Council (NFAC), and Director, Agricultural Research Office (ARO) of the Ministry of Agriculture, Quezon City, Philippines.

[2]Arturo A. Gomez, Multiple Cropping: An Approach to Rural Development, SEARCA, College, Laguna, Philippines, 1978.

Agriculture (MA). Although other agencies, like the Farming Systems Development Corporation (FSDC), agricultural colleges/universities and research institutions, like IRRI and the University of the Philippines at Los Baños (UPLB), have been working on farming systems research and extension (FSR/E), there was limited coordination with the MA regarding these activities. This is now being remedied.

There are various projects in the Philippines that are utilizing the farming systems approach. While they assume different scopes and stages of implementation, they have similarities in dealing with small farmers. The following projects serve as models on how a farming systems approach to research and development are being implemented in the country:

1. The National Multiple Cropping Production Program

Farming systems research and extension was initiated in the Philippines with the implementation of a multiple cropping pilot project at UPLB with assistance from the International Development Research Center (IDRC) of Canada. From 1972 to 1978, UPLB conducted a pilot project on multiple cropping in several villages of the Philippines to study the adoption of intensive cropping systems and its impact on small farmers. This was a modest research and extension project which explored different approaches for the introduction of upland crops and vegetables in rice- and corn-based production systems. Production technicians were assigned to pilot barangays (villages) and required to stay in the barangay and live with the farmers. These technicians assist the farmers in the preparation of farm plans and budget, including possible improvements on the existing cropping pattern. Credit and marketing institutions, as well as local officials, were tapped to support the project.

Initial success of this project resulted in the initiation of the National Multiple Cropping Program (NMCP), utilizing the field personnel of the Bureau of Agricultural Extension (BAEx) and Bureau of Plant Industry (BPI) under the overall coordination of the National Food and Agriculture Council (NFAC). The program attempted to pilot test the whole farm approach to agricultural extension, which required an extension worker who can assist the farmers in any agricultural activity in their farms instead of just on a specific commodity like rice or corn. The existing technicians were trained on multiple cropping technology suited for the various agro-climatic conditions of the country. Extension programs were developed to disseminate proven, workable, biologically stable and profitable cropping systems technology. The program tapped the credit schemes of existing programs like Masagana 99 (rice), Maisan 77 (corn) and Gulayan sa Kalusugan (vegetable) into an integrated agricultural financing scheme. Under this scheme, the farmer, with the assistance of the production technician, prepared an annual farm plan and budget for the farm activities. Loan releases and repayments were made at scheduled intervals depending on the production program developed for the farm.

Unfortunately, the centralized organizational structure of the Ministry of Agriculture (MA), where the field personnel belonged to five separate bureaus and were directly responsible to them, and the very heavy emphasis on commodity-oriented programs made it difficult to institutionalize the farming systems approach to agricultural production at this time. The concept of an extension worker who would be a generalist instead of a commodity Specialist could not be introduced at this time, as the major emphasis of the Ministry was to push the rice and corn production programs, which were then our programs for survival. The NMCP, however, was able to identify the necessary organizational structure

for promoting farming systems as a strategy for development for future use when such revisions would be favorable.

2. Rainfed Agricultural Development (Iloilo) Project (KABSAKA)

Since 1974, the multiple cropping (MC) and Rice Production Training and Research (RPTR) departments of IRRI, in coordination with the BPI and the BAEx of the MA, had a thorough study on the growing of two rice crops followed by an upland crop in rainfed areas of Iloilo and Pangasinan. The package of technology developed includes, among others, early land preparation soon after the harvest of the last dry season crop so that the land is ready for dry seeding of rice at the onset of monsoon rains in April to May. With the use of early-maturing varieties, the first rice crop will be ready to harvest in at least 100 days, and the land could be prepared for planting the second crop either by wet seeding or transplanting as early as September. If residual moisture is favorable after harvest of the second rice crop, a third crop of upland crops like mungbean, peanut or corn could be established. Figure 1 shows the relationship of this introduced system of growing rainfed-lowland rice with that of the traditional system.

Due to the promising results which show that production in rainfed areas can be dramatically increased, the KABSAKA project in the municipality of Sta. Barbara in Iloilo was expanded, with IBRD assistance, to cover the rainfed areas of Iloilo province. This project is now known as the Rainfed Agricultural Development (Iloilo) Project (RADIP). RADIP has a production program target of 60,000 hectares of rainfed rice areas in the province of Iloilo. A package of improved cropping systems technology is being extended to the farmers on a phased basis. Demonstration plots are being established. Farmers' classes and training are being conducted. Four extension centers, simple meeting halls for about 900 villagers, equipment, visual aids and vehicles for government extension staff are being provided. The project is also implementing an Integrated Agricultural Financing (IAF) scheme.

Under this project, the MA in the province of Iloilo is being reorganized so that it can implement a multiple cropping program more efficiently. Transforming rice or corn extension workers into general agricultural extension workers is, however, a very slow and difficult process.

Table 1 shows the grain yield of applied research trials of the two-rice crop system in rainfed-lowland rice areas in Sta. Barbara, Iloilo from 1974-1979 and the progress of the KABSAKA Project from 1980-1982. The significant increase in the number of farmers participating in KABSAKA by the end of the crop year 1982 is an indication of the acceptance by farmers of Iloilo of the two-rice crop production package for rainfed-lowland areas. There is an urgent need for the Ministry to look into the socioeconomic factors that led to the farmers' acceptance of the two-rice cropping system in rainfed-lowland rice areas of Iloilo and to determine to what extent the KABSAKA Project has contributed to this acceptance. There is also a need to determine the cost-benefit ratio of the Project and its replicability. The assistance of sociologists and economists from interested institutions would be most welcome, since these specialists are not readily available within the Ministry.

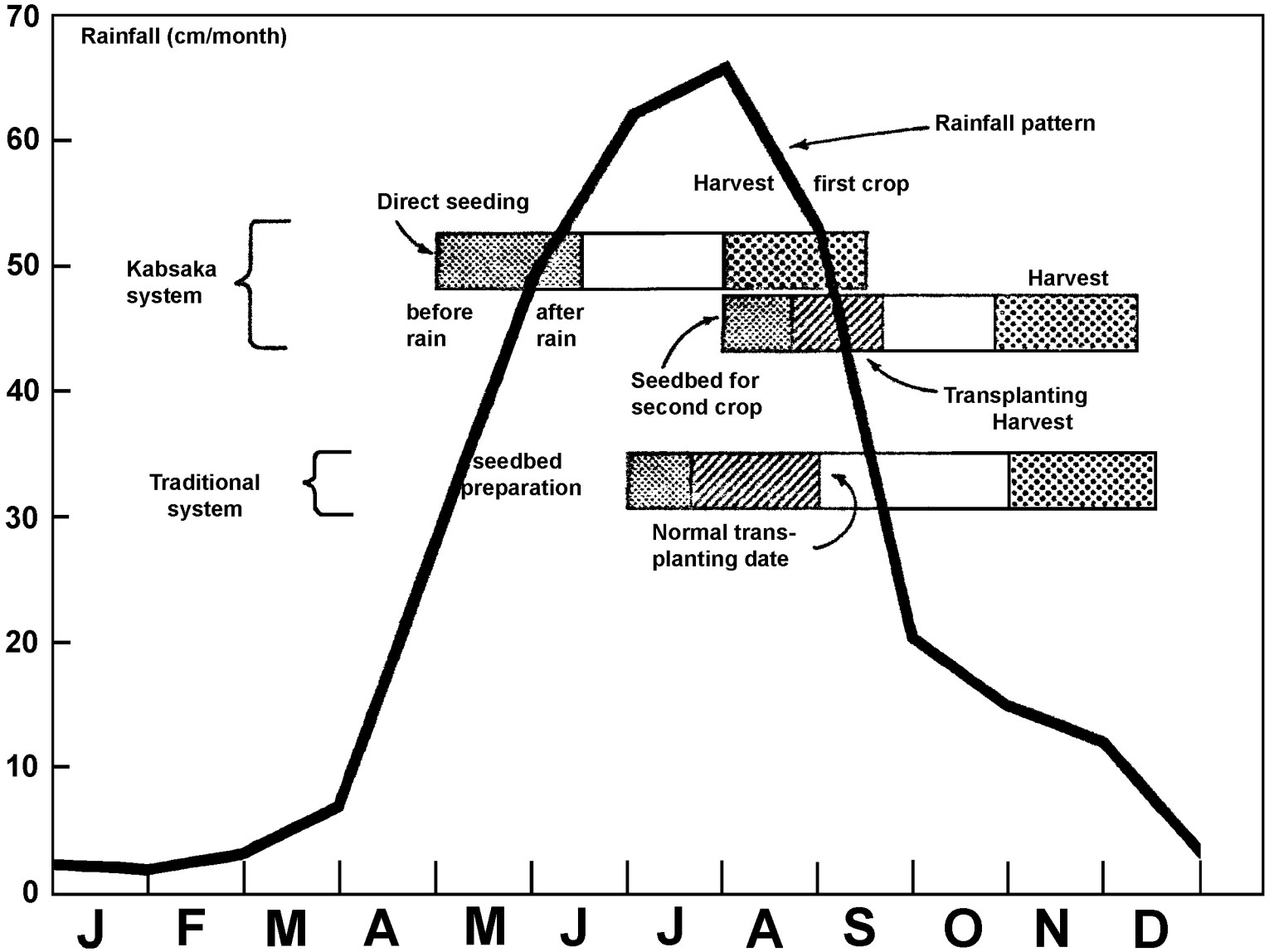



Fig. 1. Old system vs teh new as practiced by Iloilo, Philippines, farmers who adopted a two-crop system for rainfed wetland riceina project code named *Kabaska*, 1977.

Table 1. Grain Yield of Applied Research Trials of 2-Rice Crop System in Rainfed-Lowland Rice Areas, 1974-79 and Progress of the KABSAKA Project, 1980-1982.

| Project | No. of Farmers | Area (ha) | Average Yields (t/ha) | | |
|---|---|---|---|---|---|
| | | | 1st Crop | 2nd Crop | Total |
| KABSAKA, Iloilo (20 Municipalities) | | | | | |
| 1974 | 2 | 1 | 3.0 | 4.0 | 7.0 |
| 1975 | 9 | 25 | 4.8 | 5.0 | 9.8 |
| 1976 | 54 | 89 | 5.2 | 4.0 | 9.2 |
| 1977-78 | 88 | 141 | 4.90 | 1.50 | 6.40 |
| 1978-79 | 276 | 477 | 4.40 | 4.60 | 9.00 |
| 1980-81 | 1,040 | 1,500 | 4.35 | 4.15 | 8.50 |
| 1981-82 | 4,562 | 6,302 | 3.78 | 3.53 | 7.31 |

3. Agusan del Sur, Bukidnon and Capiz (ABC) Resettlement Project

Another project utilizing farming systems as an approach to agricultural development was initiated with World Bank assistance in moribund resettlement areas located in the provinces of Agusan del Sur, Bukidnon and Capiz. Initial activities in the area involved component technology testing in farmers' fields leading to the identification of packages of production technology relevant to the areas. The next stage involved the initiation of pilot production programs with the extension service taking the lead role on these activities, utilizing technologies which have been tested and adapted to the areas concerned.

The initial results of these pilot projects are shown in Table 2 and indicate that the acceptance rate of the cropping patterns being pilot-tested is not that impressive. We are hoping that the adoption rate of these recommended cropping patterns will improve in succeeding years. However, a closer look at the current production levels of the lowland rice, upland rice and corn crops, which are the major crops in the cropping pattern, indicates that the yield levels of these crops in the settlement areas have increased considerably, as shown in Table 3. In other words, the farmers who are growing rice or corn as a mono-crop have benefited from the applied research that has been conducted in the areas. These increased yields were obtained generally through the use of improved varieties, improved planting densities, and better timing and application of fertilizers. Therefore, while the adoption rate of the cropping pattern was low, the total crop yields of the components of the cropping pattern have increased.

The Ministry needs the assistance of trained economists and sociologists to explain why farmers are not adopting the recommended cropping patterns. Apparently, farmers have found that it is more advantageous to adopt only certain components of a cropping pattern. Obviously we have not taken into account some of the socio-economic factors that would favor the adoption of the cropping pattern we are recommending. We need all the assistance we can get from the economists and sociologists to develop the necessary skills to better understand the decision

Table 2. Status of the ABC/ASC pilot production oriented program (multiplication testing), 1981-82.

| Site/Cropping Pattern | No. of Farmers | | Area (ha) | | Yield (t/ha) | | | Total |
|---|---|---|---|---|---|---|---|---|
| | 1980-81 | 81-82 | 80-81 | 81-82 | 1st Crop | 2 nd Crop | 3 rd Crop | |
| A. AGUSAN SETTLEMENT (3 Pilot Barangays) | | | | | | | | |
| a. Lowland Rainfed | | | | | | | | |
| TPR-TPR | 15 | 55 | 12 | 65 | 3.06 | 2.58 | - | 5.64 |
| M-TPR-TPR | 6 | 10 | 3 | 5 | 0.60 | 3.00 | 3.96 | 7.56 |
| WSR-TPR | 5 | 9 | 5 | 10 | 3.68 | 3.73 | - | 7.41 |
| b. Upland Plain | | | | | | | | |
| C+M-C | - | 6 | - | 2 | 1.90+ 0.30 | 1.40 | - | 3.60 |
| C+P-C+M-UR | 6 | 10 | 3 | 6 | 2.40+ 2.00 | 2.20+ 0.90 | 1.46 | 8.96 |
| c. Upland Sideslope | | | | | | | | |
| C-C | 10 | 13 | 15 | 23 | 1.68 | 1.51 | - | 3.19 |
| C-UR | 6 | 8 | 4 | 5 | 1.75 | 1.33 | - | 3.08 |
| C+P-C+M-UR | 6 | 8 | 5 | 6 | 2.40+ 0.20 | 1.50+ 0.90 | 1.53 | 5.53 |
| B. BUKIDNON SETTLEMENT (3 Pilot Barangays) | | | | | | | | |
| a Lowland (partially irrigated) | | | | | | | | |
| WSR-TPR-WSR | 6 | 4 | 4 | 5 | 4.19 | 3.66 | 3.0 | 10.85 |
| TPR-TPR | - | 3 | - | 2 | 4.0 | 4.23 | - | 8.23 |
| b. Upland plateau | | | | | | | | |
| C-C-M | 9 | 15 | 2 | 5.0 | 3.55 | 3.16 | 1/ | 6.71 |
| UR-C-M | 7 | 13 | 2 | 5.0 | 4.69 | 3.11 | 0.23 | 9.03 |
| C+P-C+M | 4 | 4 | .4 | 1.0 | 1.95+ 0.31 | 1.53+ 0.28 | - | 4.07 |
| R+C-C+P | 5 | 6 | .5 | 1.0 | 2.48+ 1.66 | 3.75+ 0.55 | - | 8.44 |
| c. Upland sideslope | | | | | | | | |
| Coffee/Rubber+C-C-H | 3 | 3 | 1.0 | 1.0 | -/- + 2.02 | 2.25 | 1/ | 4.27 |
| Coffee+R-C-M | 3 | 4 | 1.0 | 1.4 | -- + 2.4 | 1.68 | 0.06 | 4.14 |
| C. CAPIZ SETTLEMENT (4 Pilot Barangays) | | | | | | | | |
| a. Lowland rainfed | | | | | | | | |
| WSR-WSR | 4 | 5 | 4 | 5 | 4.7 | 5.3 | - | 10.0 |
| WSR-WSR/Mung | 18 | 23 | 10 | 20 | 3.7 | 3.8 | 1/ | 7.5 |
| b. Upland plain | | | | | | | | |
| Corn-Peanut-C+M | 10 | 11 | 5 | 11 | 3.15 | 0.82 | 1/ | 3.97 |
| UR-UR-C | 3 | 3 | 2 | 3 | 2.1 | 3.2+ 2.4 | - | 7.70 |

1/ Third crop not established due to drought

2/ Coffee/Rubber have no yield yet

UR - Upland Rice
C - Corn
TPR - Transplanted Rice
WSR - Wet Seeded Rice

DSR - Dry Seeded Rice
P - Peanut
M - Mungbean

+ - intercrop
- - followed by
/ - relay planting

Table 3. Production profile of three (3) major crops (t/ha) in the ABC Settlement Project (1978 – 1981)

| CROPS | A G U S A N : | | | B U K I D N O N : | | | C A P I Z : | | |
|---|---|---|---|---|---|---|---|---|---|
| | BM : | Current : | Pilot : | BM : | Current : | Pilot : | BM : | Current : | Pilot |
| Lowland rice | 1.50 | 2.60 | 3.33 | 2.00 | 3.0 | 4.02 | 1.25 | 3.6 | 4.35 |
| Upland rice | 0.43 | 0.90 | 1.42 | 0.75 | 2.5 | 4.69 | 0.75 | 2.0 | 2.65 |
| Corn | 0.68 | 1.60 | 1.84 | 0.80 | 2.63 | 3.35 | 0.99 | 2.7 | 3.5 |

BM - Benchmark Data (1978-79)
Current - Current average production in the area (1981-82)
Pilot - Average production of farmer – cooperators in the pilot areas in the settlement (2-4 barangays)

making process of our farmers. We hope that we can interest our local universities to come to our assistance so that the Ministry's efforts would be more relevant to farmers' requirements and thus be more acceptable.

4. Agricultural Support Services Project (ASSP)

Early in 1982 the Philippines, with assistance from the World Bank, launched the Agricultural Support Services Project which has for its primary objective the development of the capability in the MA to develop relevant packages of production technology for the different agro-climatic and socio-economic conditions all over the Philippines, utilizing the farming systems approach. This project will provide the necessary technical and financial resources to enable the 12 political regions of the country, and the provinces within these regions, to work with farmers in identifying, improving and developing technologies developed at the nation's research centers to fit the unique situation in their areas. This activity will be the main function of the Regional Integrated Agricultural Research System (RIARS), which has recently been set up in each region. The technical backstopping for the RIARS will be provided by a team of farming systems specialists of the UPLB Small Farm Systems Program (SFSP) which will be the main responsibility of the Soils and Farming Systems Research Institute created by President Ferdinand Marcos on October 16, 1982.

A unique innovation of the RIARS is the involvement of extension workers in the verification, adaptation and packaging of production technologies in specific agro-climatic areas of the country. At present under the ASSP, one Provincial Technology Verification Team (PTVT) will be assigned to each province in an area most representative in terms of agro-climatic and socioeconomic conditions of the province. The PTVT members are selected from among the existing MA extension workers identified in the area and will continue to be part of the Ministry team in the area but given the main responsibility of technology verification, adaptation and packaging. These PTVT members will be trained in technology verification procedures and will be closely supervised by a regional technical team under the RIARS Manager, as well as the scientists and technical personnel of the Agricultural Research Office (ARO) of the Ministry, the staff bureaus and the UPLB-SFSP, which the Ministry has helped to organize and finance. We expect that the training of all the PTVT members will be finished by March 1983. The next step will be to organize provincial committees composed of the PTVT members, a provincial action officer (PAO) who is the head of the MA in the province, subject-matter specialists of the province and representatives of RIARS and all the regional staff and the farmers themselves to serve as the clearing-house of technologies to be verified, improved and eventually put together as a package of production technology. At the moment, the incorporation of processing, marketing, and livestock production activities are minimal but will be given more emphasis for future inclusion into the development of the appropriate farming system for each given area.

These efforts can now be actively pursued because in 1980 the MA was reorganized into decentralized, integrated regional offices with a regional director having line authority over the MA personnel and programs in the region. Personnel who used to be identified as Bureau of Plant Industry, Bureau of Animal Industry, Bureau of Soils, Bureau of Agricultural Economics and Bureau of Cooperatives Development and were reporting to their own regional directors have now been integrated into one MA staff, reporting to one regional director. The organizational structure that we have at present is therefore more conducive to the implementation of a farming systems approach to agricultural

development. We are hopeful that with the ASSP, the modest effort we are pursuing in a limited number of locations will lead to a better understanding of the mechanisms, organizational structures, administrative procedures, and other such information which would be useful in implementing a FSR/E approach in more locations per province nationwide.

Farmer Participation in Farming Systems Research-Extension (FSR/E)

By its very nature, FSR/E is basically an activity for small farmers who need to utilize all the resources on their farms and off-farm to obtain the maximum benefits of farming. In most developing countries there are small farmers who are already practicing some form of farming system but who are unaware that this is what their practices are called. It is therefore very essential for present and future FSR/E practitioners to invest sufficient time and resources in documenting the existing farming practices and activities of small farmers in an area before they start to design their FSR/E program. There is so much that one can learn through careful documentation of what the farm family has been doing on their farm that has enabled them to survive for many, many years. The farm family, because of their experience with their farm, is an authority, to a certain extent, on what can or cannot be done on their farm. Utilizing this expertise will therefore serve to minimize the unnecessary testing of crops or technology which the farmer has already proven beyond doubt is not feasible to adapt for the area. It is the job of the FSR/E practitioner to determine in close consultation with the farmer what else can be done or how much better activities can be improved in the farm. He or she should also be sensitive to the resources of the farmer so that innovations to be tried are affordable or adaptable by the farmer. The experience of the farmer and the technical expertise of the FSR/E practitioner should complement each other in the development of improved, adaptable practices for the farmer's unique situation.

It has been observed, however, that it is invariably those farmers who have more resources than others that would be selected as farmer-cooperators. They are the ones who are in a better position to take some risks or contribute the time and money required for the trial and error involved in the development of the appropriate farming system for the area. This has been cited by some as a disadvantage. On the other hand, these farmers are the ones other farmers watch. They are also oftentimes the only ones in the site who are willing to take a risk on trying the new technology we want to introduce. It is therefore very important for the FSR/E implementer to find the right balance between this kind of farmer and the "average" farmer in choosing co-operators in FSR/E activities.

In the PIARS that we are establishing, we are making the farmer a key participant in the decision-making on what should be done in the farm to improve existing practices. In many instances, however, the farmers have the tendency to accede to the suggestions of the younger researchers and extension workers. They are usually polite and would not tell our technicians that what is being suggested has already been tried and has not worked. Instead, they just go along with our technicians until the technicians themselves find out that what they have suggested is not workable. The challenge is therefore for our technicians to draw the farmers out and make them feel that their input is vital and that if they feel some of the suggested innovations are impractical, they should speak out so that better alternatives can be found. This will result in savings in time and finances in the long run.

The Ministry realizes that it has to invest some of its resources toward better understanding the human side of farming so that it can be better equipped in encouraging farmers to be more confident in themselves and speak out freely on issues affecting them. The Ministry needs to learn how to develop the capability of farmers to interact with and to demand such services that they are entitled to from the Ministry and the government. It is in this area that our Ministry is appealing for the active involvement of the social scientists, particularly the rural sociologist, anthropologists, community organizers and applied communication specialists. We are sad to report that response to this appeal has not been too encouraging.

FSR/E is a joint effort between the farmers, the researchers and extension workers. The active participation of all three is essential for the successful implementation of this approach to agricultural development.

# RELATION OF FARMING SYSTEMS RESEARCH TO COMPONENT RESEARCH PROGRAMS [1]

William H. Judy [2]

## Introduction

Farming Systems Research (FSR) has come to have different meanings for many people, but it is a useful methodology which has come to be endorsed by foreign development agencies and institutions, even in its differing guises. Because FSR has such deep support currently, it behooves us to strive to develop a clear conceptual framework for each approach and assess the impact that each approach can have upon donor and development institutions, both in LDC's and in those nations that support development through either financial, technical assistance, or conceptual (academic) means.

FSR seeks to bring together research, extension, and the farmer to identify, establish priority for, and solve constraints to agricultural productivity. Constraints can be considered within the farming-living situation, but the methodology takes into account the policy and support system environment.

One part of FSR is the methodology - the Farming Systems Approach to Research, Extension, and the Farmer - FSAR/E. One part of FSR is the approach to policies and support systems. One part of FSR is the FSR practitioner.

This paper focuses on the FSR that includes the approach to component research with some consideration given to the practitioner. Some US/AID activity in introducing the FSR methodology is discussed in Section 7.

## Levels Or Stages Of Research and How FSAR/E Could Affect Each

1. Basic Research: Generation of knowledge for which there may be no current or immediately foreseeable use or application.

2. Applied Component Research: Replicable investigation to address the parts or the whole of a constraint. Applied research is directed to one of the following areas:

   a. Commodity - maize, rice, beef cattle

   b. Discipline - breeding, pathology

   c. Problem - disease, plant lodging, soil management

---

[1] Presentation at the Farming Systems in the Field Symposium held 21-23 November 1982 at Kansas State University, Manhattan, Kansas. The views presented herein are those of the author and do not represent the official policy of the Agency for International Development.

[2] Senior Agricultural Research Officer in the Technical Resources Office for Agriculture and Rural Development in the African Bureau of the Agency for International Development, Washington D.C., U.S.A.

Effect of FSAR/E: Can be applied at several points in the system to assist in:

- Identification of all constraints
- Establishing the priority for selecting constraints for research
- Defining the research problem
- Describing the methodology

3. Verification Research: Extending the applied component research to evaluate research results in a replicable manner with the end user.

   Effect of FSAR/E: Generally considered to be a major activity of the FSP practitioner to:

   - Involve research, extension, and farmer
   - Describe target group of farmers
   - Assist in selection of evaluation sites
   - Assist in methodology, conduct of research, and evaluation

4. Demonstration and Extension: Spreading the research results which are found to be biologically and economically viable and acceptable to the target group of farmers.

   Effect of FSAR/E: Considered to be a major activity of the FSR practitioner to:

   - Involve extension and the farmer
   - Assist in selection of methodology
   - Assist in evaluation of adoption

<u>Geographic Domain of Research Unit and How FSAR/E Could Affect Each</u>

1. Ecological/Sociological Domain: The research system is organized to address the needs of a homogenous area defined by ecological parameters but with consideration given to sociological, agricultural, and political parameters.

   Effect of FSAR/E: Can be applied to system.

   a. <u>Sub-National Domain</u>: The FSAR/E can be utilized effectively, assuming proper attention to cost effectiveness.

   b. <u>Regional (Multinational)</u>: The FSAR/E can be effective when there is an established mechanism for researchers to readily share planning and evaluation of research results across national boundaries.

2. National or Sub-National Domain: The research system is established to address the needs of agriculture for the entire country or for some sub-national geographical area.

   Effect of FSAR/E: Can be applied to system. Success in adjusting research program will be affected by:

   - Institutional linkages of research and extension
   - Mandate given to research and to extension

- Level of training of research and extension
- Skill of research and extension administrators in recognizing and addressing national policy issues

3. Regional (Multinational) and International Center: The system is organized to address commodity, discipline, or problem oriented research.

   Effectiveness of FSAR/E: Can be applied to some parts of the institution and its program. Success in adjusting research program will be affected by:

   - Mandate of the institution
   - Number of definable constraints
   - Geographical site of institution
   - Effective linkages between institution and national research programs
   - Resources available to the institution

<u>The Research Program and Organization of an Institution Doing Component Research Can Be Affected in Several Ways</u>

1. The statement of the research problem can be changed.

2. The order of priority of constraints to agricultural productivity can be realigned.

3. Scientists of different disciplines can be added or deleted.

4. The locale of part of the research can be changed from on-station to on-farm.

5. The research organization can be restructured and links can be established with extension.

<u>The Current Status of the Component Research Organization Will Determine How It Will Be Affected by FSAR/E</u>

1. Young, active and building.

2. Mature, sedentary or deteriorating.

3. Under design or redesign.

<u>Component Research Programs Can Be Affected by FSAR/E in Several Ways</u>

1. The component research program could be completely altered. The changes would be observed in the following:

   a. The statement of constraints, methodology, and packaging of results.

   b. Addition of disciplines such as socio-economic.

   c. Establishment of institutional linkages with extension.

   d. Addition of on-farm research activities.

2. The component research program could be influenced by organizational or philosophical changes.

   a. Addition of evaluation units.

   b. Addition of liaison office between research and extension.

   c. Training workshops for research scientists.

3. The component research program could be completely unchanged or unaffected by FSAR/E. Therefore, other ways must be developed to introduce FSAR/E. Some possibilities include:

   a. Introduce FSAR/E in extension organization.

   b. Establish parallel research organization.

   c. Utilize appropriate research results from other institutions and organizations.

4. The institution may not be able to revise its component research program to include other commodities, disciplines or problems because of mandate or funding constraints.

<u>Some Actions Are Underway to Utilize or to Introduce the FSAR/E in Development Programs</u>

1. In Sub-Saharan Africa by US/AID.

   a. In Bilateral projects:

      (1) FSAR/E written into research and extension parts of projects.

      (2) Research Extension Liaison Officer established to bridge organization.

      (3) Pre-Program Paper survey conducted to identify target groups and major constraints.

   b. In Regional projects:

      (1) Farming Systems Support for Eastern and Southern Africa national institutions to train and network scientists (implemented by CIMMYT).

      (2) Farming Systems Research portion of SAFGRAD project to identify constraints of major target groups (implemented by Purdue University).

   c. In world-wide projects:

      (1) Science and Technology Project on Farming Systems Support to supply technical assistance to plan, evaluate, and solve implementation problems; to conduct training and workshops; to establish a documentation and communication system; and to conduct research on state-of-the-art FSR issues (implemented by University of Florida and associated universities).

(2) Proposed Science and Technology Project on Cropping/Livestock Systems Research to develop an approach which can be used to carry out integrated cropping/livestock/ forestry research (initially in humid tropics at IITA).

2. US/AID Agricultural Development and Rural Development Officer's Workshop participants in May 1982 adopted Farming Systems Research as a "Common Themes" focus and approved the D.W. Norman paper "Institutionalizing the Farming Systems Approach to Research" as a definitive document for FSAR/E in US/AID programs in Africa.

3. In Sub-Saharan Africa by other organizations.

   a. Farming Systems Research team to develop a methodology which can be used by ICRISAT to identify major constraints and evaluate research findings.

   b. Proposed Farming Systems Research and training unit to be developed at IITA to establish FSR practitioner networks and training workshops.

   c. Proposed IFAD project to organize FSR units in three Sahelian countries where SAFGRAD ACPO's are located.

   d. The Cooperation for Development in Africa (CDA) agricultural research initiative has as one basic premise the reorienting of research to address the total farming - living situation of the small scale commercial farmer with more emphasis on socio-economics. The U.S. is technical coordinator of this seven donor nation effort which will ultimately affect all 42 African countries to some degree.

<u>The Concept and Method of Institutionalizing the FSAR/E is a Major Problem</u>

1. The FSR unit might be separate from the component research unit.

2. The FSR unit might be established either in the research or in the extension unit.

3. The FSR unit might be established partly within both the research and extension units.

4. The FSR unit might be established in some other unit of administration such as planning or the University, where research is the mandate of the Ministry of Agriculture.

5. The total research and extension organizations might be reorganized to incorporate the FSAR/E.

<u>Risks</u>

Some problems have developed within the FSR methodology which should be addressed by its proponents. Some are inherent within the concept, some are peculiar to certain approaches, and others are imposed from without by financial, political, or other causes.

1. The system can become too costly in terms of people and money.

2. Practitioners may tend to make decisions for farmers rather than offer farmers true choices.

3. FSR design may not take into account replicability which is a requirement for prediction; thus, no extension of trials results can be extended beyond the first test site.

4. FSR may address only the current situation with no forward-looking or anticipatory research being proposed.

5. Form may be substituted for substance, e.g. determining the current situation (descriptive stage) may not be translated quickly into intervention stage.

6. Disillusionment with cost or lack of progress may erode LDC and donor support for FSR.

7. Terminology has not been descriptive, leading to confusion about the concept and its approaches to problem solving.

8. Biological, social, and economics scientists have not always worked together as a team.

9. FSR has not developed a proposal for dealing with the policy and support system perspectives which affect the farming-living system.

## Conclusion

Farming Systems Research is a useful methodology which has received wide support. It can be used to reorient component research toward research on critical constraints to productivity. The various approaches to FSR need to be described more accurately and the cost/benefit established for some typical developing country systems. There is no one FSR model which can be prescribed for every country, but rather the model should be developed to take maximum advantage of the research and extension institutions in recognition of the absorptive and participatory capacity of predominant farming-living systems.

# STRATIFICATION: AN APPROACH TO COST-EFFECTIVENESS FOR FARMING SYSTEMS RESEARCH AND DEVELOPMENT

W.W. Shaner*

## Introduction

The Consortium for International Development (CID) recently completed a study (Shaner et al., 1982) of farming systems research and development (FSR&D). The objective of the study was to prepare a set of procedures that could be used by national governments, and others, to improve the production and general welfare of farmers with limited resources in the developing countries. This study emphasized the identification of procedures developed by practitioners of FSR&D that would be suitable for the resources and capabilities of developing country institutions.

While gathering data on the project, we were challenged by some that FSR&D was not cost-effective. They charged that FSR&D devotes too many resources -- mainly scarce researchers -- to too few farmers. By following an FSR&D approach, other research activities must be cut back thereby shortchanging the country's total research program. This is FSR&D's so-called site specific problem.

Even though FSR&D researchers recognize the potential problem of site specificity, those researchers contacted during our study generally do not agree that site specificity needs to be a problem. They argue that a sizeable impact on a country's small-scale farmers can be produced because of FSR&D's cost-effectiveness.

This effectiveness centers on three points (Harrington, 1980). First, while FSR&D may appear to be costly because of recurring travel and per diem expenditures and its use of interdisciplinary teams, experiment station research is also expensive, considering the opportunity cost of experiment station facilities and the relatively high costs of station personnel. Moreover, FSR&D is believed to lead to a higher rate of improvements per unit of expenditures than more traditional research, although this contention is not well documented. Second, FSR&D staff has developed survey and research procedures for reaching targeted farmers and producing improvements quickly. Third, FSR&D researchers usually attempt to provide improvements to farmers' conditions that are better than their current practices but not necessarily the best that could be offered. The reasoning for this tactic is that the cost in moving from better to best exceeds the value of the improvements.

The second and third points combine to make FSR&D an effective means for quickly introducing improved technologies to the targeted farmers. When successful, FSR&D teams can either consider further means for improving conditions among the same farmers or work with new farmers where conditions are different. FSR&D procedures include a means for transferring research results to those farmers not directly participating in the FSR&D experiments. This transfer of results is the development portion of the methodology (the "D" in FSR&D), which is accomplished by integrating extension into field-team activities during the research process.

---

*W.W. Shaner is Associate Managing Project Director for the Water Management Synthesis project and Associate Professor in the College of Engineering at Colorado State University, Ft. Collins, Colorado.

Success, however, is dependent on the FSR&D teams' abilities to identify enough farmers operating under essentially the same conditions so that the transfer of results extends to enough farmers. Identifying such farmers and their conditions is consequently a key, in my opinion, to FSR&D's cost-effectiveness. The various approaches to this identification is the subject of this paper.

More specifically, this paper's objectives are to 1) bring to light what others have been doing in stratifying farmers' circumstances so as to make FSR&D more cost-effective and 2) suggest areas for further research. Ultimately, alternative approaches to stratification need to be refined and taught to many so that this task is not left to a few "renaissance men" who have the gift for identifying the relevant conditions for effective research.

The following sections deal first with the way stratification fits into the FSR&D methodology. Then, three approaches to stratification are described. The paper closes with some ideas for further research. Sources for much of this paper came from the CID team's literature review and visits with those following a farming systems approach -- primarily related to crops.

## Stratification

Stratification begins with the selection of a target area and proceeds to a subdivision of this target area into areas of environmental commonality. These subdivisions are further divided by identifying farmers with common characteristics -- called recommendation domains. Below are sections that summarize the five basic activities of FSR&D and describe the stratification of target areas and the identification of recommendation domains.

### Five Basic FSR&D Activities

A synthesis of the various approaches to FSR&D produced the five basic activities shown in Fig. 1 (Shaner et al., 1982). These activities are: 1) target and research area selection, 2) problem dentification and development of a research base, 3) planning on-farm research, 4) on-farm research and analysis, and 5) extension of results. Selecting the target and research areas therefore sets the stage for the subsequent activities.

The basis for selecting the target area is generally a combination of policy objectives and the area's technical potential. Once selected, on whatever grounds, the area is stratified according to sub-areas of commonality. Then FSR&D teams select areas of research to include one or more of these sub-areas, depending on research objectives and the relative importance of individual sub-areas. Interdisciplinary teams then study secondary information and conduct field studies to identify problems justifying their attention. In the process, the FSR&D teams organize the information collected and begin to gain an understanding of the area's characteristics. That is, the teams develop a base for implementing their research programs. Research activities are planned during the third phase. During the fourth phase, research is carried out and the results analyzed. Finally, successful results are turned over to extension or other implementing agencies for broad-scale implementation.

Completing the diagram of activities are the collaboration with extension and the experiment stations and the feedback of results. Such collaboration demonstrates FSR&D's complementarity with other research and development.

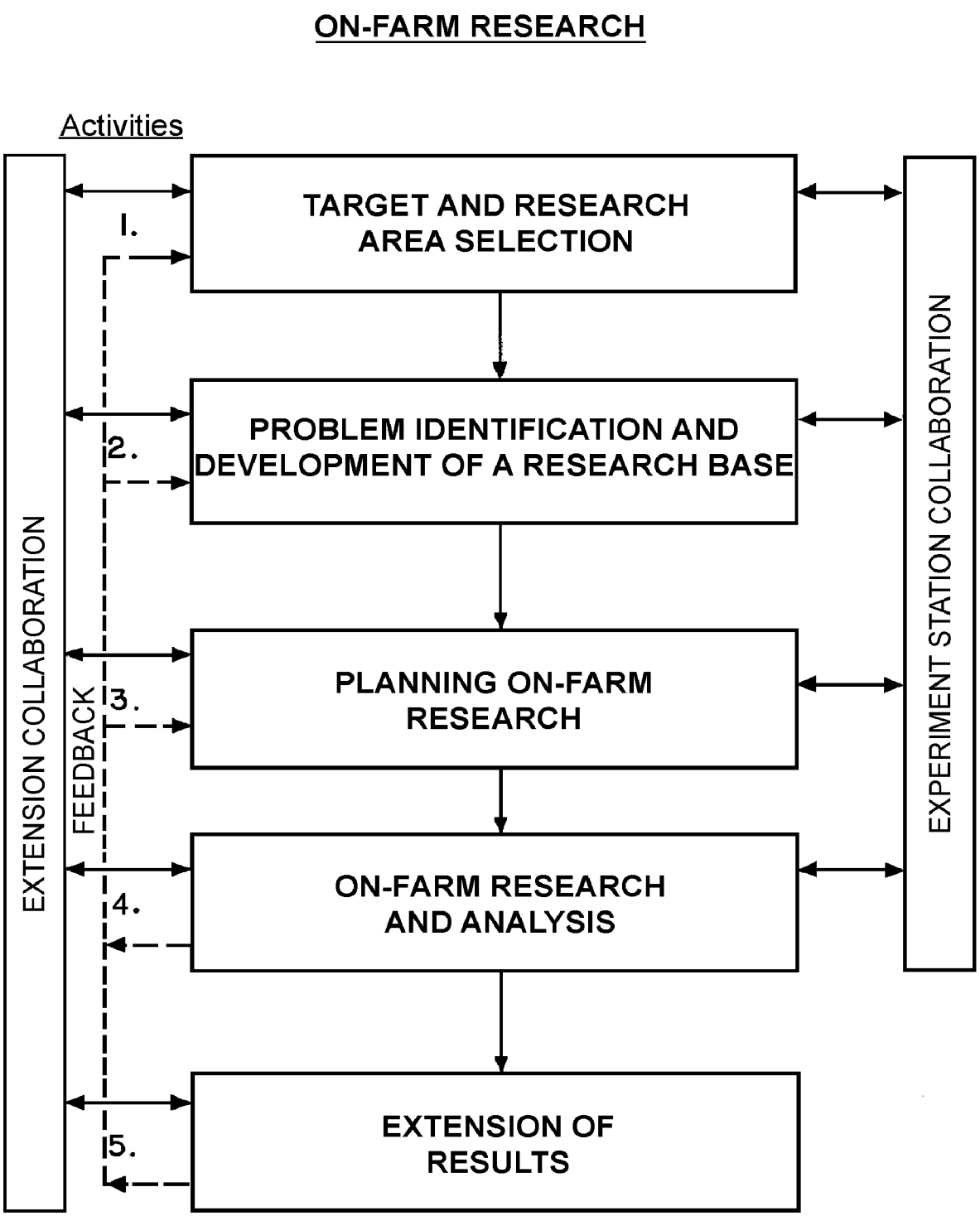



Figure 1. The Five Basic Activities of FSR&D (Shaner et al., 1982).

activities in the region, and the feedback demonstrates the iterative process of progressively improving the research approach by using the results of previous research.

These activities are described in greater detail in Shaner et al. (1982) and in the book's references.

## Stratification of the Target Area

Stratification of the target area is part of the first FSR&D activity whereby the target area is divided according to areas of commonality. This commonality refers to the range of physical, biological, economic, and socio-cultural factors that characterize small farmers' problems and the FSR&D team's opportunities for identifying and implementing technologies, policies, and other means for improving farmers' conditions. For example, target areas have been stratified according to soils, rainfall, temperature, access to markets, and social customs.

Because of the heterogeneity so common within agricultural areas, these sub-areas refer to the general conditions prevailing in the target area. Actually, conditions within a sub-area can be quite diverse because of differences in factors such as terrain, soil fertility, farm size, farmers' resources, and cropping patterns. As a result, to be fully useful in conducting the research, farmers in the sub-area with whom the researchers collaborate need to be further screened according to their common characteristics -- assuming research applies to areas where farmers have established operations. Obviously, such considerations would not apply to areas of colonization where farming has not been established.

This further division of a sub-area into its components of commonality produces what CIMMYT calls recommendation domains.

## Recommendation Domains

According to Byerlee, Collinson et al. (1980), a recommendation domain is a "group of roughly homogenous farmers with similar circumstances for whom we can make more or less the same recommendation. Recommendation domains may be defined in terms of both natural factors (e.g., rainfall) and economic factors (e.g., farm site)." The concept of recommendation domains has strong appeal. This is in spite of the heterogeneity found among farmers and farmers' conditions and the objections about having to define the domains before the recommendations are made. For example, Zandstra finds difficulty with the concept because a domain's characteristics depend on the nature of some future recommendation; and these characteristics cannot be fully known until research in the area has been carried out (personal communication). Still, researchers have applied the essential features of recommendation domains in a variety of forms, as will be shown in subsequent sections. Also, CIMMYT (1981), recognizing Zandstra's point, identifies the area for research on a preliminary basis and then modifies the domain's description as necessary.

On an abstract level, a recommendation domain can be considered as that group of farmers to the left of the intersection of the curves representing the profitability to individual farmers and the minimum profitability level (see Fig. 2). The shaded area (recommendation domain) represents the conditions whereby the net benefits of an improved technology exceed the farmers' demands of a new technology. The heterogeneity among the farmers and farmers' conditions

explains the divergence in net benefits. Not withstanding this diversity of results, researchers will have succeeded in identifying the recommendation domain if most of the farmers who find the new technology acceptable were previously identified as those being within the domain. A point brought out by Byerlee, Collinson et al. (1980) is that these farmers are not necessarily contiguous and can be scattered throughout the target area.

Returning to Zandstra's argument, one could expect a different set of curves (fig. 2), and thus different domain parameters, for each technology. This reasoning leads to the conclusion that recommendation domains take on two characteristics: first, they can be used to set broad conditions for research, such as fundamentally different soil types; and second, the more specific the domains become, the more frequently they need to be redefined as the technologies change or as more is learned about the domains. Some examples of recommendation domains follow.

Norman and Gilbert (1982) suggest that research strategies need to be appropriate for each recommendation domain. Thus, "families in a particular subgroup will tend to have similar farming activities and include similar social customs, similar access to support systems, comparable marketing opportunities and similar present technology and resource endowment." After considering such a range of activities, the Kansas State University (KSU) team decided that the critical factors on which to base its initial research effort could be boiled down to three major domains: 1) relatively wealthy farms with a distinct emphasis on livestock, 2) marginal mixed crop and livestock farms, and 3) sub-marginal mixed farms with a crop emphasis (Bussing et al., 1982). The distinguishing factors in identifying these domains were the power source (i.e., size of the livestock herd) and the size of the family's holdings.

In a study of a maize producing valley in one of the South American highlands, CIMMYT (1981) identified four recommendation domains according to altitude, irrigated or rainfed agriculture, main planting dates, vegetative cycle, incidence of disease, and the disposal of the maize crop. In another example, this same report identified two basic recommendation domains: one on flat lands and another on steep lands. Using these two divisions, major differences were found in the way farmers prepared the land, in their choices of plant varieties, and in their weeding practices. More recently, Byerlee et al. (1980) hypothesized that tractor ownership -- i.e., those who owned tractors and those who rented them -- was the distinguishing factor on which to stratify farmer types within a highland valley of Mexico. Their reasoning was that those who owned tractors could prepare the land and plant their crops at more appropriate times than those who had to wait until tractors were available. This hypothesis was then tested for statistical significance according to cropping patterns, farmers' resources, and land preparation practices. While the results showed a number of factors as being significant, such as dates of land preparation and the number of times a field was harrowed, the authors concluded that these differences were not significant enough to warrant separate recommendation domains when planning experiments. Clearly, this was a matter of judgment that needs testing as that research program progresses.

## Approaches to Stratification

The foregoing suggests a variety of approaches and bases for dividing farmers into distinct recommendation domains. Moreover, while differences in conditions can be identified, the researchers are often left with largely

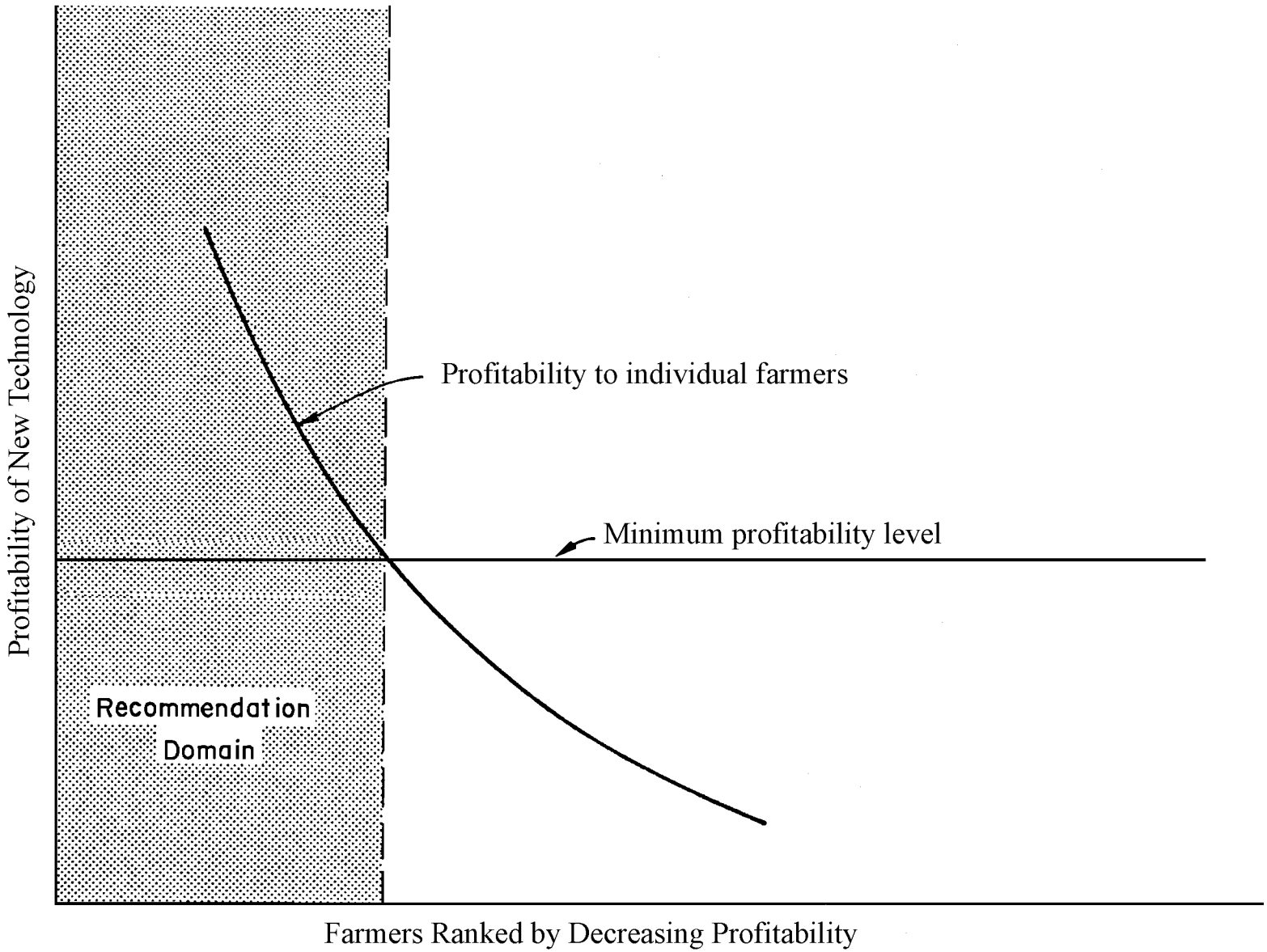



Figure 2. Recommendation Domain Defined as the Set of Farmers Who Would Find a New Technology Acceptable.

judgmental decisions as to the degree of homogeneity to attempt to capture through the stratification of farmers' conditions. In the light of these uncertainties, a more thorough consideration of the way researchers treat this subject seems in order. Some of the more recent work along these lines is discussed next.

Descriptive Schemes

Several authors have studied farmers' systems with the intent of gaining a better understanding of a family's activities and its means of production. Below are brief accounts of three different approaches to the subject.

Classification of Farming Systems: Writing on tropical agriculture, Ruthenberg (1971) comments that some form of classification of farming systems is necessary for devising meaningful agricultural policies -- even though no two farms are organized exactly alike. By focusing on farm management characteristics, he divides farming according to whether its functions are primarily collecting, cultivating, or using grasslands. Cultivation systems have been the primary focus of FSR&D work to date. Within this classification, Ruthenberg distinguishes among activities according to type of rotation (e.g., ley systems, field systems with one crop following another, and perennial crops), intensity of rotation, water supply (e.g., irrigated or rainfed), cropping pattern and animal activity, implements used for cultivation, and degree of commercialization.

For a particular farming system, insight into farming activities can be gained by studying the system's natural environment and the critical aspects of the socio-institutional setting. McArthur in Ruthenberg (1971) looks at climatic influences, soils, and biological conditions within the natural environment. He mentions that critical problems may include soil fertility, coping with risk and uncertainty, low labor productivity, and seasonality of water supply. In closing his description, Mac-Arthur reminds us of the dynamic nature of tropical farming. Even though farms can be classified and described, farmers continually make minor adjustments to their production processes because of changing conditions. This practice of adjustment provides the opening for introducing improvements through approaches such as FSR&D.

Agricultural Growth Stages: Harwood (1979) expands on Ruthenberg's classification by noting that agriculture progresses through a series of stages: namely, hunting and gathering, crop and animal husbandry subsistence, consumer orientation, early commercial orientation, mechanical power for tillage, and finally mechanical power for additional farming activities. While researchers have often used the last stage as their ideal on the assumption that increase in labor productivity through mechanization is the objective, Harwood suggests that such an ideal is obviously inappropriate for those partially or wholly subsistence farmers with limited resources. In contrast, Harwood believes that FSR&D teams can usefully spend part of their initial efforts in an area by identifying the farmers' stage of agricultural growth. Such an understanding helps set the research direction, since labor productivity, number of farm enterprises, and cash and skill requirements will vary with the different stages of development.

Harwood (1979) uses the following factors to identify a farmer's stage of development: degree of commercialization, predominance of labor activities, cropping systems, use of draft animals, untended pigs and chickens, complementarity of interactions between crops and between animals, and the contribution of family production to its nutrition. For example, permanent agriculture with

low commercial activity typically supplies most of its own food and relies heavily on the complementarity between crops and between animals. In such cases, farming becomes complex due to "intensive intercropping, nutrient cycling, diversified and highly developed mixed planting of homestead areas, and a delicate crop-animal balance (that maximizes) productivity in an environment where external resource use is being minimized..." (Harwood, 1982). In contrast, shifting cultivation and commercialized agriculture are not nearly as complex nor as intensive users of land.

An Ecological Systems Approach: Hart (1982a) applies Odum's (1971) and others' ecological systems approach to understand better the interactions within the farm household and between the household and its environment. Using this construct, the farming system is seen as part of a larger system that is made up of cropping, livestock, or mixed subsystems. These subsystems in turn can be broken down into subsystems of individual crops and animal types.

Such a systems approach permits Hart to focus on individual components of the farming system for general understanding and for subsequent quantification. For instance, for a cropping system, study can be initiated on "an arrangement of crop populations that process energy (solar radiation) and material inputs (soil nutrients and water) to produce outputs (crop yield). The crop population can be arranged both spatially (planting distances) and chronologically (date of planting)."

Hart's use of an ecological approach provides considerable insight into a farm's activities and the degree to which the farm is in physical, biological, and economic balance. In one of his studies, Hart (1982b) began by identifying a representative farm within a region. The principal farming activities and interactions were next shown graphically. Then data on inputs were gathered weekly for an entire year to quantify the farm's activities.

This year-long study's results provided Hart with a means both for adapting Odum's principles of ecology to FSR&D and for analyzing the interactions of a complex farming system. Hart also used his findings to train students in FSR&D methodologies (Hart, 1979). The approach is therefore investigative and pedagogical, rather than part of an FSR&D program aimed at improving farmers' conditions directly. More direct approaches to FSR&D are described next.

Stratification by Components

In searching for methodologies applicable to FSR&D, Shaner et al. (1982) came across a number of relevant approaches to the stratification of farmers and their environments. Some of these approaches are described below under the headings of agro-climatic zones, soil and land classifications, cropping and the biological environment, farmers' cultural practices, farmers' characteristics, and socioeconomic conditions. Each of these has a bearing in selecting representative farmers and environments for an FSR&D approach.

Agro-climatic Zones: Agro-climatic zones are areas distinguished according to their suitability for generally broad categories of agriculture. Rainfall and temperature (especially in mountainous areas) are widely used in evaluating an area's agricultural potential. Also, measures of potential evapotranspiration have been used to classify arid and semi-arid areas according

to "homo climates" (Chang, 1980). However, Chang suggests that 1) such broad classifications are usually inadequate for research purposes, 2) the climatic boundaries are seldom appropriate for specific crops, and 3) mean values of temperature, precipitation, and potential evapotranspiration are seldom sufficient by themselves. Instead, Chang calls for greater attention to the phrenological requirements of specific crops, solar radiation, photo period, temperature extremes, and wind. The local nature of FSR&D makes such attention to detail a reasonable requirement.

At a more applied level, Hargreaves (1977) derived a moisture availability index for identifying water deficiencies and excesses. This index is computed by dividing the dependable (75 percent probability) precipitation by the potential evapotranspiration. According to Hargreaves, "monthly indices are fairly adequate for most planning and development needs. However, whenever serious doubt exists relative to the validity of the use of monthly values, daily data can be used to estimate daily, 5-day, 10-day, or 15-day values and indices. Use of comparisons between monthly values and those for shorter time periods has added confidence in the use of monthly indices." CIAT, IITA, and others have built some of their research work around the Hargreaves method.

Where FSR&D's responsibilities are spread over areas with different climatic conditions, then Lawson's approach to experimentation seems relevant. Lawson of IITA in Nigeria would have researchers plan their agronomic experiments after carefully studying the climatic conditions for their areas of responsibility. When experiments are selectively placed and climatic data adequately recorded, results of cropping experiments can be more adequately interpreted in the light of actual conditions. Also, yield responses under varying climatic conditions can be better understood (personal communication).

Soil and Land Classification: Considerable work has gone into classifying soils and land types for agricultural purposes. Examples include FAO's framework, IRRI's land types, the soil temperature and moisture regimes of Van Wambeke, and Cochrane's work at CIAT.

FAO (1976) proposes six principles for classifying land for agricultural use. These are 1) lands should be classified for specific kinds of use, 2) different types of land require comparisons based on the potential benefits and costs of their use, [3) missing] 4) evaluations should take account of the area's physical, economic, and social conditions, 5) an area's suitability should be based on its long-term use, and 6) alternative uses for an area require investigation. In going through this classification process, researchers will be able to compare actual with potential land use.

Zandstra et al. (1981) provide recommendations more specifically to the physical characteristics of an area. They explain that land types "must be sufficiently different to merit the development of a different technology for each..." Their classification of land types considers terrain (e.g., plain and bottomland), major soil type (e.g., balo loam and loba clay), water table depth during the rainy season, hydrology (e.g., pluvic and fluxic), flooding hazard (e.g., absent and 1 in 10), major present use (e.g., rice-fallow and tree crops), and potential use (e.g., rice-rice and "as is"). These classifications have been applied by IRRI in its cropping systems research.

More narrowly related to soils, for broader application, is the work of Van Wambeke (e.g., 1982) on soil moisture regimes in Africa. This approach

combines soil temperature and moisture regimes to classify soils. Van Wambeke states that the "reason for using soil climates is that they are the causes of many other properties...some soil characteristics are only meaningful when they are considered in a limited area restricted to a defined soil climate... [and] major soil limitations for plant growth are implied" by the classification. Such broad-scale classifications as Van Wambeke's are primarily useful in 1) grasping an area's general soil and climatic characteristics and 2) comparing the area's agricultural research and production results with the results from other areas.

While working with CIAT in Colombia, Cochrane et al. (1979) extracted data from reports, transferred these data to computer storage, and then produced computer-aided maps of soil characteristics. Data on climate, soils, and landscapes were then correlated with crop production and the results used to locate areas of major importance for CIAT's cropping and livestock research programs.

As another application of soil and climate classification, Palmer et al. (1978) mapped the six ecozones in Kenya in studying the potential of the so-called marginal lands in the Machakos-Kitui area. These six zones were divided according to the ratio of rainfall to potential evapotranspiration. Overlays were then placed on these six zones to account for soil characteristics and for slope. The resulting classifications were then used to search for improvements in agricultural technologies suitable for semi-arid conditions.

Cropping and the Biological Environment: Crops, cropping patterns, and pests are commonly used as a basis for characterizing farms in an area. Several of the International Agricultural Research Centers have a strong commodity focus. Also, national agricultural research programs often build on crop breeders and experiment station programs centered on specific crops. Another reason for focusing on specific crops is that most small farmers simply do not readily change their basic crops. Consequently, in stratifying agricultural areas, attention needs to be given to the types of crops grown and the stability of the cropping patterns.

Biological problems associated with insects, diseases, weeds, and other pests are also factors frequently deserving attention. Research areas were zoned in Sumatra on the basis of the particularly troublesome grass (Imperata cylindrica). In Ecuador, Winkelmann and Moscardi (1982) report that insect patterns (which were closely related to altitude) and access to irrigation were the two factors that established the three recommendation domains.

On a somewhat different level, Jones (1979), while working with CIAT in Colombia, conducted an agro-climatic survey of bean production in South America. The objective of the survey was to identify the climatic conditions of the region's major bean producing areas. Disease and pest problems, yields, and other relevant characteristics of bean production could then be related to climatic characteristics, and CIAT's research program for beans could be set accordingly.

Note should be made that Jones' approach to the interaction between crops and agro-climatic data contrasts with the FAO study for Africa (1978). The FAO study identifies locations in which the environments are suitable for producing particular crops, whether the crops are grown there or not. Knowledge of potential production areas according to individual crop requirements is useful as

a starting point in the search for new crops or cropping patterns for an area. Additional information, however, is needed on a crop's or a pattern's performance in an FSR&D research area, since crops sometimes are grown outside the recommended areas and crops are frequently not grown within a recommended area. As a partial explanation of the foregoing situations, most area classifications such as FAO's are useful primarily as guides that still require on-site research. Consequently, anomalies are to be expected. Also, the suitability of agro-climatic conditions is only part of the reason farmers choose the crops they grow.

Farmers' Cultural Practices: Farmers' cultural practices offer a variety of opportunities for classification. Categorization of farming types according to such practices was mentioned earlier when discussing the approaches of Ruthenberg and Harwood. Some of the characteristics offered as being important in such classifications are access to, and the use of, animal or mechanical power, communal or individual activities, use of purchased inputs, and general knowledge about, and application of, available technologies. On a more specific level, farmers differ in their methods of land and seedbed preparation, planting dates, plant populations, spacings, row geometry, variety selection, maintenance of soil fertility, pest management, and harvesting and storage methods.

The extent to which the foregoing become important in dividing farmers into separate groups depends largely on how strongly farmers maintain their customs. Hildebrand has said of the small farmers in highland Guatemala that "you don't mess around much with the farmers' maize." Some of these farmers' planting practices are tied in strongly with their beliefs and customs. For example, they are loath to thin maize plants. In contrast, Zandstra and McIntosh have said that many of the small rice farmers in Southeast Asia readily experiment. This characteristic perhaps helps to explain the rapid acceptance of improved rice varieties in that region.

Economic Conditions: Economic factors include those "endogenous" factors under the farmers' control and those "exogenous" factors outside the farmers' control (Gilbert et al., 1980). To the extent that farmers will change practices under their control, then such factors are probably not a basis for stratifying farmers into separate groups. On the other hand, differences in factors outside the farmers' control could be a basis for stratification, provided such factors strongly affect farmers' practices and are likely to remain unchanged.

Some of the exogenous factors likely to influence farmers' actions are land availability and rental rates, share cropping arrangements when established by custom, land pressures, size of holdings and fields, input supplies and markets for farmers' output, price stability, availability of services (e.g., credit, extension, transportation, water, storage and processing facilities, and electricity), surplus labor for hire, availability of consumer goods, and so on.

Some of the endogenous factors include the farmer's choice of farming enterprises, allocation of the family's resources (including especially family labor), division between on-farm and off-farm employment, and division of the family's output between consumption and sales.

Farmer decisions over these endogenous factors may in large part be set by the family's income, assets, and general standard of living. The closer the family is to bare subsistence, the less flexibility for reallocating the family's resources. The KSU team used this distinction as one of the bases for stratifying farmers in Botswana (Bussing et al., 1981). Along this line of reasoning, Hildebrand (1978) says that in "commercial agriculture, the tractor and a strong capital base are effective homogenizers of what is otherwise a complex milieu." In other words, the greater the farmers' resources, the less need for stratification on economic grounds.

Socio-cultural Conditions: Some of the endogenous economic factors discussed above shade into the socio-cultural setting so that the division between the two categories is somewhat arbitrary--e.g., land rental and share cropping arrangements. Even so, further discussion of socio-cultural conditions seems in order. The essence of knowing whether to stratify farmers according to sociocultural conditions rests with a reasonably accurate appraisal of how readily farmers change their farming systems. For this, an understanding is needed of the farm family and its socio-cultural environment.

Concerning the farmer, Beal and Sibley (1967) studied Guatemalan farmers' potential for change based on statistical analyses of farmers' characteristics (e.g., age and sex), knowledge (e.g., information about alternative management practices), beliefs (e.g., emotions and sentiments), behavior (e.g., marketing practices), and goals (e.g., family desires).

Knowing farmers' attitudes and behavior when confronted with risk or opportunities for leisure can influence both the timing of the introduction of change and the nature of that change. According to the Beal and Sibley study (1967), farmers' education, age, and frequency of visits to metropolitan areas are some of the variables that correlated with the adoption of new technologies. Where the distinction among a group of farmers is strong enough, stratification into separate groups should be considered. Family preference for red or black beans may be important in varietal selection during research design, but it may not be sufficiently basic to justify stratification.

Institutional factors also help share farmers' acceptance of change and, hence, deserve consideration. Land tenure and share cropping arrangements, cooperation during times of social or economic stress, organizations for regulating water use in irrigation systems, and religious laws and customs are some of the social factors that may distinguish farmer groups. Farmers who herd livestock compared with sedentary crop farmers is a rather obvious basis for stratification. Differences in religion, on the other hand, may not be important. Henderson (1980) points to the flexibility religion provides its followers.

Concluding Remarks: This section on stratification has described some of the many factors to consider when attempting to identify conditions of commonality and diversity. Systematically considering all possible combinations of such a multidimensional matrix is surely a futile exercise in orderliness. The number of factors to consider combined with the difficulty I see in trying to reach meaningful conclusions probably explains my intuitive skepticism of the value of general benchmark surveys and my feeling that FSR&D's emphasis on early initiation of experiments is correct.

But all possible combinations do not need to be considered when seeking to stratify farmers and farmers' conditions into researchable units. Some factors are subsumed within categories (e.g., climate within elevation) and other factors are subsumed across categories (e.g., disease within elevation). From experience, FSR&D practitioners have been able to identify what they believe are some of the dominant factors in arriving at suitable stratifications. Below are examples of what might be called strategies for stratification.

Strategies for Stratification

A strategy for stratification is simply an educated, possibly intuitive, approach for identifying those factors that are truly critical in establishing the conditions for conducting research. When the recommendation domains have been correctly selected, the researchers can feel reasonably confident that technologies acceptable to farmers participating in the teams' experiments will have broad applicability throughout the recommendation domains.

Strategies taken by the Agricultural Science and Technology Institute (ICTA) of Guatemala, CIMMYT, ICRISAT, and IRRI cover a variety of approaches. Reports by those associated with these programs indicate the success of their approaches, which concentrate on only a limited number of factors. Many of the other factors, identified in the previous sections, eventually get worked into the research designs; most are not employed, however, in establishing the recommendation domains.

The ICTA Strategy: A rather ingenious approach to stratification is that developed by ICTA (Hildebrand, 1978). In this approach, reconnaissance teams crisscross an area in search of commonality among farmers. This commonality centers on cropping patterns (e.g., maize intercropped with beans), production methods (e.g., variety selection and time of planting), and farmers' resources (e.g., access to income from off-farm employment). The approach is relatively simple to implement, since the characteristics being sought are generally observable or are of the type farmers readily recall and do not mind revealing. The approach focuses on the farming system's characteristics, i.e., cropping patterns and yields, with some investigation of the reasons for these yields, e.g., time of planting and access to off-farm income that allows the farmers to purchase agricultural inputs. Research on farmers' fields, with farmers actively participating, and farmers' production records subsequently form the basis for confirming or modifying the initial selection of farmers.

The advantage of this approach rests with the assertion that the output of a farming system integrates a complexity of environmental and farmer-related factors. For example, the variety, time of planting, cropping pattern and rotations, and yields reflect soil and climatic conditions, farmers' preferences, market conditions, and so on. By focusing on what actually comes out of the system, the researcher links onto the reality of the system and is relieved of expensive and oftentimes complex data collection and analysis.

The major drawback to this approach, as I see it, centers on two limitations. First, without having detailed data on the environment (e.g., soils and climatic characteristics), farmers' reasons for accepting or rejecting changes may be inadequately understood. Second, commonalities in farm output may hide basic differences in farmers' conditions and management. For instance, differing soils or microclimates could be offset by differing inputs

of labor and materials and still yield essentially the same results. Some of these differences will become apparent from the on-farm trials and records, but more thorough knowledge of the physical, biological, and socioeconomic environments would help in designing experiments and understanding the results. Budget and staffing constraints very likely account, at least in part, for ICTA's lesser attention to these factors.

The CIMMYT Strategy: Much of CIMMYT's FSR&D efforts centers on farming systems in which maize is the dominant crop in the farmers' cropping patterns. Partly as a result of its mandate, the focus on maize is both a restriction and a part of its strategy for selecting recommendation domains. Once maize farmers are identified, CIMMYT researchers search for major distinguishing factors. As in the earlier examples, stratification can be according to elevation, where disease and frost are factors. In other cases, intercropping with beans and available labor may be singled out as distinguishing factors. For example, "different disease incidences for beans... cause farmers in one part of the agro-climatic environment to plant beans early, therefore delaying maize planting, (so that in) this case recommendation domains may result from natural circumstances (i.e., diseases) affecting bean production and an economic circumstance (i.e., labor scarcity) translating this effort onto maize practices" (Byerlee, Col-linson, et al, 1980). Other factors noted in this same reference include distinctions according to water source (irrigated or rainfed), main planting dates, vegetative cycle, and the nature and extent of maize sales.

The ICRISAT Strategy: ICIRISAT is "concerned with the development of farming systems which would help to increase and stabilize agricultural production through the better use of the natural and human resources in the seasonally dry, semi-arid tropics..." (Krantz, 1982). Fundamental to its farming systems research has been the identification of two distinctive soil orders: Alfisols and Vertisols. Because of differences in clay content, these two soils impose substantially different cropping, management, and risk factors on the region's farmers. Moisture retention is considerably higher in the Vertisols in spite "of their lower saturated hydraulic conductivity, (because surface cracks allow) higher initial intake rates and less runoff in the early rainy season than do Alfisols" (Krantz, 1982). The result of this difference in moisture availability is a growing season of 17 weeks for Alfisols and 26 weeks for Vertisols. These differences show up in the choices of crops, planting times, decisions on water storage, risk of loss, and related factors.

The IRRI Strategy: Fundamental to IRRI's approach is its efforts to intensify rice-based farming. Because of this focus, areas conducive to rice production are sought out. Accordingly, physical conditions related to soil texture, dependability of rainfall, terrain, and type of water system are evaluated for their suitability for alternative types of farming. As examples, soils are categorized according to their water retention capacity; rainfall is categorized according to the number and continuity of months of rainfall in excess of 200 mm and less than 100 mm; terrain is distinguished according to land types such as terrace, bottomland, plateau, and sideslopes; and water supply is divided according to irrigated and rainfed systems and to the likelihood of flooding (Zandstra et al., 1981). Referring to these factors, Zan-dstra (1982) says that "double cropping rainfed lowland rice in regions with more than 200 mm rain for six months may be possible in heavy textured soils but not in light textured soils."

The logic of concentrating on these particular factors becomes apparent when one understands IRRI's strategy of intensifying rice-based farming. In contrast, temperatures are not a major factor because of the generally uniform climate throughout the region. Also, less attention is directed to socioeconomic factors because IRRI's experience shows that rice farmers are generally willing to participate in IRRI's and host countries' experiments--more so than many of the more tradition-bound farmers in parts of Central and South America.

By focusing on the physical environment, IRRI researchers have developed considerable information on the region's rainfall, land types, and related characteristics. Such information forms a base for identifying areas with common physical characteristics where rice varieties and other technological factors can be introduced. Such information also aids in explaining experimental successes and failures. The ability to devote resources to such environmental studies is one of the advantages of the International Agricultural Research Centers, as compared with many national programs.

## Ideas for Further Research

The foregoing sections defined recommendation domains and illustrated the concept, gave examples for describing farming systems, showed ways for stratifying farmers and farmers' conditions that ranged from agro-climatic zones to socio-cultural factors, and closed with some strategies to cut through the maze of detail by identifying a few strategic factors on which to concentrate.

But has the effort devoted to stratifying farmers and farmers' conditions been adequate? From our review of the literature and discussions with FSR&D's practitioners, I believe that much more could be done to document the successes and failures of the different stratification schemes. Perhaps, such documentation will come forth as the FSR&D approach matures.

I further believe that FSR&D can be made cost-effective by increasing the potential for broad-scale transfer of research results among regions with similar conditions. In time, as some researchers suggest, portions of FSR&D results can probably be extrapolated to areas where conditions are somewhat different from those in which the experiments were conducted. These and other thoughts will be amplified in the remaining sections of this paper, which cover agro-climatic zones, soil classification, modeling, and conclusions.

## Agro-climatic Zones

Interesting work recently or currently being carried out in the general area of agro-climatology includes that of Chang, Lawson, Jones, FAO, Nygaard, Hargreaves, Virmani, and undoubtedly others.

Chang (1968) brought attention to the need for relating the fundamentals of climatology to the specific requirements of individual crops. He stresses the critical influence on plant performance of photo period, night-time temperatures, moisture's effects on plant diseases, wind stress, and similar climatic factors. Chang's continuing work in this area (1980) needs to be followed closely.

Lawson of IITA expressed interest in more carefully defining relevant climatic characteristics for individual crops and in planning experiments to test crop responses across gradients in West Africa. For example, he notes

that for similar moisture zones, radiation decreases because of increased cloudiness when moving from west to east; and that moisture decreases and radiation increases when moving from south to north. Judicially locating experiments within this region could provide important information about crop performances under varying climatic conditions. This and similar efforts need to be followed, as for example Jones' work at CIAT on correlating crop performance with climatic characteristics and FAO's work in agroclimatic zoning (FAO, 1978).

For the future, ICARDA plans to collect data that will allow it to identify agro-climatic zones in the drier areas of Western Asia and Northern Africa. Nygaard anticipates that this "characterization requires the assessment and recording of critical agro-meteorological parameters in conjunction with other relevant details of crop phenology, soil moisture supply, soil nutritional status and agronomic management" (ICARDA, 1981).

Currently, Hargreaves' moisture availability index (1977) is being applied to the work of several institutions, including IITA and CITA. This approach helps in identifying irrigation and drainage needs and in selecting crops according to moisture regimes.

On a somewhat different level, Virmani et al. of ICRISAT (1978) have gathered data and developed procedures for the semi-arid tropics that use conditional probabilities to aid in reaching decisions on crop selection, planting times, water storage, and similar matters.

Advances along the foregoing lines will certainly aid in our knowledge about how to stratify areas according to agro-climatic characteristics. Consequently, a review and synthesis of this and related efforts seem highly desirable.

Soil Classification

Similar to the studies involving agro-climatology, opportunities also exist for learning from the various studies being conducted or recently completed. Isolating crop performance according to differences in soil characteristics is possible in the Philippines and Indonesia because of the similar climatic conditions encountered widely in these countries (Harwood, personal communication). Alternatively, the Soils Benchmark Project of the Universities of Hawaii and Puerto Rico is "designed to test the hypothesis that agro-production technology can be transferred to other areas with similar agroecological conditions. To test this hypothesis, a network of experimental sites was established in the Philippines, Indonesia, Cameroon, Brazil, Puerto Rico and Hawaii..." (Brady, 1982).

As noted earlier, computer-aided analysis and graphics are being used by Cochrane at CITA (1979) to relate soil and other relevant characteristics to crop performance. This work should aid in identifying significant factors to stratification according to soil types. This, and the results of Van Wambeke's soil moisture zones offer opportunities for comparison.

Studies of soil gradients, such as that of Burgos at CATIE (1979), show how soil characteristics change with terrain. Burgos' study looks at locational effects on soil texture, pH, fertility, and other factors. Another approach to soil gradients might be found by following up on Plucknett's suggestion of using transects to infer changing soil conditions from the differences in vegetation encountered across agro-climatic zones (National Research Council, 1977).

Integrating soils with climatic studies could further enrich current understanding of how crops perform under varying conditions.

Modeling Studies

Modeling offers another largely untapped potential for assisting FSR&D researchers in stratifying conditions according to relevant physical, biological, and socioeconomic environments. Hart's (1982b) experiments in applying the methodologies of ecological systems analysis appear to offer important opportunities for understanding the various components of a farming system and for studying energy, nutrient, and water balances at the farm level.

Eventually, mathematical modeling could add sophistication to the study of the complexities of farming systems (Valdes and Franklin, 1979, and Wymore, 1976). Simulation of alternative farming systems could build on approaches such as that of Hart, thereby providing knowledge of how farming characteristics might change under alternative conditions. An advantage of such mathematical modeling is the opportunity to test the effects of changes to the farming system through sensitivity analysis. Such analysis points to the more relevant factors affecting the system, which thereby become appropriate topics for research. However, those who plan to model small farmers and their environments should heed Johnston's warning about the complexity of ill-structured problems. The complexity relates to the "host of variables and changing inter-relationships among those variables [that make] complete knowledge and understanding impossible" (Johnston, 1982), which has its implications for effectively obtaining useful results.

Conclusions

In conclusion, considerable progress has been made by FSR&D practitioners in identifying the relevant factors for stratifying environmental conditions in a way that meaningful recommendation domains can be established. But much more remains to be done, as indicated by some of the research described above. The TAC report (1978) says that the importance of defining agro-climatic zones "cannot be overestimated, for a successful (FSR&D) program must depend heavily upon (a) a careful analysis of the land and climatic base; (b) an understanding of the extent and importance of major land systems or complexes; (c) an understanding of present land use patterns on given land systems; (d) an understanding of environmental-technology interaction; (e) a basis for setting of priorities for (FSR&D) work, particularly in relation to the farm systems to be studied and resource use and management issues; and (f) a basis for transfer of technology from research to the farmer, especially where the natural resource base is a major determinant in management systems." Undoubtedly, practitioners in the socioeconomic fields could add similar statements regarding their areas of expertise. These subjects have only partially been covered by those concerned with FSR&D.

Eventually, one might seek to reach Harwood's ideal of being able to parachute into an area without knowing where, to look at a set of parameters, and then to design a technology. This concept follows the idea of making farming systems research a science rather than an art and of developing and teaching a universal design capability that allows one to add or drop a crop or modify a farming practice (personal communication). This idea may not soon be reached. But it is worth striving for and, in so doing, the question of FSR&D's cost effectiveness could eventually become a dead issue.

## REFERENCES


Beal, G. M., and D. N. Sibley. 1967. Adoption of Agricultural Technology by the Indians of Guatemala. Rural Sociology Report No. 62. Department of Sociology and Anthropology. Iowa State University, Ames, Iowa.

Brady, N. C. 1982. AID's Soil Management Activities. In Soil Taxonomy News No. 3: 3-4.

Burgos, C. F. and R. Meneses. 1979. Performance of Cropping Patterns Across a Soil Texture Gradient in Costa Rica. A paper presented at the 71st Annual Meeting of the American Society of Agronomy. Ft. Collins, Colorado, 5-10 August 1979.

Bussing, C., J. Converse, B. Koch, L. Van Withee, T. Nkwe, and E. Modiakgotla. 1981. Recommendation Domains for Districts in Central and Francistown Regions of Botswana: Final Report. Farming Systems Research Team, Kansas State University, Manhattan, Kansas.

Byerlee, D., M. P. Collinson, R. K. Perrin, D. L. Winkelmann, S. Biggs, E. R. Moscardi, J. C. Martinez, L. Harrington, and A. Benjamin. 1980. Planning Technologies Appropriate to Farmers: Concepts and Procedures. CIMMYT, El Batan, Mexico.

Byerlee, D., L. Harrington, and P. Marko. 1980. Farmers' Practices, Production Problems and Research Opportunities in Barley Production in the Calpulalpan/Apan Valley, Mexico: Working Paper, CIMMYT, El Batan, Mexico.

Chang, J. 1980. A Climatic Consideration of the Transference of Agricultural Technology. A paper prepared for the Farming Systems Research and Development Methodologies Project. Consortium for International Development, Tucson, Arizona.

Chang, J. 1968. Climate and Agriculture. Aldone Publishers, Hawthorne, New York.

CIMMYT. 1981. CIMMYT today No. 13, April. CIMMYT, El Batan, Mexico.

Cocharane, T. T., J. A. Porras, L. Azevedo, P. G. Jones, and L. F. Sanchez. 1979. Explanatory manual for CIAT's Computerized Land Resource Study of Tropical America. CIAT, Cali, Colombia.

FAO. 1978. Report on the Agro-Ecological Zones Project, Vol. 1: Methodology and Results for Africa. World Soil Research Report 48. FAO, Rome. 1976. A Framework for Land Evaluation. Soils Bulletin 32. FAO, Rome.

Gilbert, E. H., D. W. Norman, and F. E. Winch. 1980. Farming Systems Research: A Critical Appraisal. MSU Rural Development Paper No. 6, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

Hargreaves, H. 1977. Water Requirements Manual for Irrigated Crops and Rainfed Agriculture. Utah State University, Logan, Utah.

Harrington, L. 1980. Methodological Issues Facing Social Scientists in On-Farm/Farming Systems Research. A paper presented at a CIMMYT Workshop on Methods. Issues Facing Social Science in On-Farm Farming Systems Research, 1-3 April 1980. CIMMYT, El Batan, Mexico.

Hart, R. D. 1982a. An Ecological Systems Conceptual Framework for Agricultural Research and Development. p. 44-58. In W.W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

1982b. One Farm System in Honduras: A Case Study in Farm Systems Research. p. 59-73. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

1979. Agro ecosistemas: Conceptos Básicos. CATIE, Turrialba, Costa Rica.

Harwood, R. R.1982. Farming Systems Development in a Resource-Limiting Environment. p. 1-6. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

1979. Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics. Westview Press, Boulder, Colorado.

Henderson, H. 1980. Anthropological and Sociological Principles of Farming Systems Research and Development. A paper prepared for the Farming Systems Research and Development Methodology project. Consortium for International Development, Tucson, Arizona.

Hildebrand, P. E. 1978. Motivating Small Farmers to Accept Change. A paper presented at the Rockefeller Foundation Conference Center, 18-23 October 1978. Bellagio, Italy. ICTA, Guatemala.

ICARDA. 1981. Farming Systems Program. ICARDA, Aleppo, Syria.

Johnston, B. F. 1982. Design of Rural Development: A Policy Analysis Perspective. A paper prepared for the ISEDS Seminar Series at Colorado State University. November 12, 1982, Ft. Collins, Colorado.

Jones, P. G. 1979. Agro climatology Study. CIAT manuscript. CIAT, Cali, Colombia.

Krantz, B. A. 1982. Farming Systems Research at ICRISAT. P. 135-156. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

National Research Council. 1977. Resources for Agriculture. In Supporting Papers: World Food and Nutrition Study, Vol. II. National Academy of Sciences, Washington, D.C.

Norman, D. W., and E. Gilbert. 1982. A General Overview of Farming Systems Research. p.17-30. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

Odum, E. P. 1971. Fundamentals of Ecology. Saunders, Washington, D.C.

Palmer, B. C., W. W. Shaner, C. Gichochi, C. T. Hash, and B. M. Mbatha. 1978. Kenya Marginal/Semi-Arid Lands Pre-Investment Inventory, Report No. 1: Analysis and Project Identification. Consortium for International Development, Tucson, Arizona.

Ruthenberg, H. 1971. Farming Systems in the Tropics. Clarendon Press, Oxford, UK.

Shaner, W. W., P. F. Philipp, and W. R.Schmehl. 1982. Farming Systems Research and Development: Guidelines for Developing Countries. Westview Press, Boulder, Colorado.

Technical Advisory Committee (TAC). Review Team of the Consultative Group on International Agricultural Research. 1978. Farming Systems Research at the International Agricultural Research Centers. The World Bank, Washington, D.C.

Valdes, A., and D. L. Franklin. 1979. Evaluation of Design Parameters for Cattle Production in the Colombia Llanos. p. 83-101. In A. Valdes, G. M. Scobie, and J. L. Dillon (editors). Economics and the Design of Small-Farmer Technology. Iowa State University Press, Ames, Iowa.

Van Wambeke, A. 1982. Calculated Soil Moisture and Temperature regimes of Africa. SSMS Technical Soil Moisture and Temperature Regimes Service, USDA, Washington, D.C.

Virmani, S. M., M. V. K. Siva Kumar, and S. J. Reddy. 1978. Rainfall Probalities for Selected Locations of Semi-Arid India: Research Report No. 1. ICRISAT, Hyderabad, India.

Winkelmann, D., and E. Moscardi. 1982. Aiming Agricultural Research at the Needs of Farmers. p. 31-43. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

Wymore, A. W. 1976. Systems Engineering Methodology for Interdisciplinary Teams. John Wiley & Sons, New York.

Zandstra, H. G. 1982. A Cropping Systems Research Methodology for Agricultural Development Projects. p. 74-99. In W. W. Shaner, P. F. Philipp, and W. R. Schmehl (editors). Readings in Farming Systems Research and Development. Westview Press, Boulder, Colorado.

Zandstra, H. G., E. C. Price, J. A. Litsinger, and R. A. Morris. 1981. A Methodology for On-Farm Cropping Systems Research. IRRI, Los Banos, Philippines.

# FSR/E AS A FIELD METHODOLOGY IN THIRD WORLD COUNTRIES; ITS HISTORICAL ORIGINS, CURRENT FUNCTIONS, AND SUGGESTIONS FOR IMPROVEMENT[1]

Frank S. Conklin[2]

It is exciting to be in a position of both observer and participant to the evolutionary process of FSR/E (Farming Systems Research and Extension). It is equally exciting to have been asked to participate formally in KSU's second FSR symposium. As an observer last year, I sensed the frustration of some participants who were disappointed that a more operational orientation was not provided. The more general perspective, however, seemed appropriate at that time to provide participants from diverse disciplines a common focal point (Sheppard). That goal was achieved and I am pleased we were able to move on this year to operational issues of FSR/E in the field.

For my part in the program, I have chosen to focus upon FSR/E as a field methodology, what it offers, what gaps it currently embraces, and my perception of how such gaps may be overcome. I believe this is necessary if we truly desire to help farmers in LIC's (Lesser Income Countries). To conduct this exercise, three questions are advanced. An historical perspective responds to those questions to help us understand how FSR/E evolved and what unfinished business remains.

The questions are:

1. Why did FSR/E emerge, and what felt needs did it seek to address for third world agriculture?

2. What are the qualities or characteristics of FSR/E currently?

3. What operational shortcomings remain with FSR/E which need attention?

To answer these questions I have leaned heavily upon the emerging body of FSR/E literature. Review of said literature and its embellishment with my own professional perspective and experience from development, operation, and end of project roles on agricultural technical assistance projects provides the backdrop.

## Synoptic History of Agricultural Technical Assistance in LIC's with Roots from the U.S. Experience

Agricultural Technical Assistance (research and development) models are the product of industrialized nations introduced into LIC's largely through the mechanism of donor grant and loan projects. The mechanism has built in perceptions from the donor country of what it takes to achieve the generalized objective of "increasing production of basic food crops and livestock products thereby increasing income and well being of the agricultural sector" in the host country.

---

[1]Prepared for the Farming Systems Research Symposium, Kansas State University, November 21-23, 1982.

[2]Professor of Agricultural and Resource Economics, Oregon State University, and former CID Scholar/ Deputy Director, Tucson, Arizona.

Such goals and perceptions certainly are not new. They have been a cornerstone of technical assistance for three decades. The nine AID project papers cited in the reference section may be used as examples. But less well recognized are the actual impacts felt within recipient countries. A refresher history lesson will serve the purpose and we do not have to look any further than our own country to focus upon technical assistance. A statement by Benjamin Franklin, circa 1784, titled Remarks Concerning Savage of North America provides the appropriate illustration.

Franklin wrote:

> At the treaty of Lancaster in Pennsylvania, anno 1744, between the Government of Virginia and the Six nations, the commissioners from Virginia acquainted the Indians by a speech, that there was at Williamsburg a college with a fund for educating Indian youth; and that if the chiefs of the Six Nations would send down half a dozen of their sons to that college, the government would take care that they be well provided for, and instructed in all the learning of the white people.

The Indians' spokesman replied:

> We know that you highly esteem the kind of learning taught in those colleges, and that the maintenance of our young men, while with you, would be very expensive to you. We are convinced, therefore, that you mean to do us good by your proposal and we thank you heartily.
>
> But you, who are wise, must know that different nations have different conceptions of things; and you will not therefore take it amiss, if our ideas of this kind of education happen not to be the same with yours. We have had some experience of it; several of our young people were formerly brought up at the colleges of the northern provinces; they were instructed in all your sciences; but, when they came back to us, they were bad runners, ignorant of every means of living in the woods, unable to bear either cold or hunger, knew neither how to build a cabin, take a deer, nor kill an enemy, spoke our language imperfectly, were therefore neither fit for hunters, warriors, nor counsellors; they were totally good for nothing.
>
> We are however not the less obligated by your kind offer, though we decline accepting it; and, to show our grateful sense of it, if the gentlemen of Virginia will send us a dozen of their sons, we will take care of their education, instruct them in all we know, and make men of them.

Thus, technical assistance depends a great deal upon the nature and usefulness of the assistance to the intended recipient. Whyte, in 1967, made the point in a slightly different way. He states that "The chief difficulty (of technical assistance) is in the organization models men (from the Western world) carry around in their heads."

Three organizational models for technical assistance have been used. They are, (1) the European Colonial model, (2) the U.S. land grant system model, and (3) the rural development model. This taxonomy is documented in Dr. William F.

Whyte's monograph Participatory Approaches to Agricultural Research and Development, Cornell University, May 1981.[3]

The European Colonial Model was placed into African and Asian colonies prior to WWII to meet food needs of the mother countries. It was large-scale, capital intensive, labor saving, and plant-science-research oriented. Scientists and western world managers guided the operation, making it "top-down" in perspective. Adapting this model for work with the masses of small LIC farmers proved fruitless. National independence ended the colonial era and with it the colonial model. Vestiges still remain, however. The post-WWII reconstruction era introduced the U.S. land grant model to the Third World, with its research, teaching, and extension components.

The land grant university system has contributed significantly to making U.S. agriculture the most productive in the world and continues to be an important source of technology. It embraces a "bottom-up" design in which U.S. farmers identify major problems, and this knowledge is transferred through the extension system. Farmers' sons have been the researchers, teachers, and public servants of the system and have been kept "relevant" through their "roots" at the farm. The technical break-through of the gasoline engine in 1900-1920's, irrigation of the West after 1920, and plant genetics producing hybrid seed corn in the 1930's formed the cornerstone of the agricultural bio-mechanical technology revolution after WWII which has typified U.S. agriculture (Hayami and Ruttan). The revolution is characterized by farmer adoption of relatively capital intensive, labor saving, and land using technology. This is ideal for a country which, relatively speaking, is endowed richly both with land and capital while facing a scarce labor supply attracted by high wages in industry. While initially the process involved expansion onto new lands, it later involved intensification and specialization of the existing land base to increase unit land production through irrigation, biological improvement, and more intensive capital inputs including fertilizer, pesticides, and large-scale machinery. The role of the researcher has been largely to foster further refinement of the same kinds of technology and the extension service to deliver it. Some of the extension responsibility has been taken over by private industry. In economic parlance the quest has been for technology which is cost-reducing and output stimulating to maximize return on capital investment as the relatively abundant resource and maximize output per unit of labor as the relatively scarce resource. As U.S. agriculture became more specialized and single commodity oriented, especially after WWII, so also did the land grant system to meet farmer needs. New disciplines emerged and departments became highly specialized and quantitative in their thrust. The land grant model of today is a blend of "top-down" and "bottom up" information transfer, serving a highly educated and skilled agricultural clientele.

The U.S. agricultural scene just described is that of the 1980's. It was not always like that. It is a product of the changing forces which have molded and shaped U.S. agriculture over the past 200 years (Hayami and Ruttan).

---

[3]A somewhat different, but equally useful taxonomy which provides a political economy perspective is presented by Alain de Janvry in his book The Agrarian Question and Reformism in Latin America. In it he presents six models used in Latin America: (1) Community development, (2) diffusionist, (3) land reform, (4) rural development, (5) basic needs, and (6) transnational agri-business. Models (1), (2), and (4) are comparable to those used by Whyte.

Agricultural technology of the 1800's was largely mechanical in nature, developed in England by private innovation. A public system was initiated in the U.S. with establishment of the USDA and the land grant university system in 1862. However, the first state agricultural experiment station was not established until 1887 when federal funding by the Hatch Act was provided. Land expansion was the major thrust until about 1900. This was followed by biological technology advances for land intensification. Extending knowledge to farmers was not formalized within the system until passage of the Smith-Lever Act in 1914. Thus it took 50 years for the U.S. to make fully operational the land grant university concept and then another 50 years before accelerated technology adoption occurred at the farm level. Extension was not a delivery mode for research initially. At that time there was little, if any, linkage between research and extension. Often they were administered separately. In the formative years, extension was truly a "bottom-up" organization, identified directly with farmers, often received considerable financial support from farm organizations, and focused upon fine tuning of the limited existing technology available. Extension farm management personnel conducted descriptive studies in the Cornellian tradition to help researchers understand farmer problems. This extension approach gave way to the screening and transfer of new technology after 1950 as the prestigious sputnik era placed researchers into the limelight. Farm management shifted to use of micro-economic theory and quantitative tools, (1) to facilitate actual decision making at the farm level and (2) to help screen the myriad of new technologies for economic profitability.[4]

The purpose of this history lesson has been to create awareness that, (1) the U.S. land grant model we are exporting today is a 1982 model, (2) the 1982 model is designed to meet the needs and problems of U.S. agriculture, (3) the 1982 model is vastly different from the 1920 and 1940 models, and (4) institutions are a product of the time and circumstances from which they emerge.

The next part of our history lesson is to demonstrate that the U.S. model is flawed for direct use in LIC's (Hayami and Ruttan, Johnson and Kilby, Timmer), and that we are re-learning lessons for LIC's we once learned for the U.S.

The first attempt at using the land grant model overseas was simply to export the product of that system, the technology itself. Extension carried the banner of "have technology, will travel." The LIC's were not as lucky as the U.S. was in importing machine technology from England in the early 1800's. Rusted, large farm equipment in LIC's is mute testimony of that initial thrust. Vestiges of that approach continued through the 1960's and into the 1970's. Examples are legion. Next, a research thrust was given the spotlight. The premise was that "basic" research knowledge could be exported through an institution-building mechanism so that U.S. technology could be developed and adapted to the local environments. Added to the monument of rusted tractors now are unfinished

---

[4]The publication of Earl O. Heady's "Blue Bible" titled Economics of Agricultural Production and Resource Use in 1950 was the first major application of micro-economic theory to farm decision making and designed for graduate student use. This was followed closely on its heels by a number of popular undergraduate farm management texts including Bradford and Johnson, Castle and Becker, and Heady and Jenson. They were not replaced until the late 1970's when sophisticated undergraduate production economics texts, strong both in micro-economic theory and quantitative tool applications, emerged. They include those by Doll and Orazem, Forester and Ervin, and Wittcoski and Wells.

edifices, unused microscopes, understaffed soil testing laboratories, inoperable electrical equipment, stalled vehicles and machinery, and trained technicians from the middle and upper urban classes of the third world who have limited knowledge about their own country's agriculture (Conklin). The result is a more sophisticated version of the earlier "technology transfer" model. Such a "top-down" model which limits basic research to the industrialized countries and application of that research knowledge to LIC's has made little contribution to the LIC's (Whyte). Not since the yield increasing technology break-through of the Green Revolution on irrigated lands in the late 1960's has there been a major increase in third world food production, in spite of massive technical assistance from the World Bank, USAID, and other international donors.

The1960's and 1970's also saw development of a competing model to the land grant model. It was called Rural Development and emerged largely from socio-economic planners. This model incorporated popular participation of the masses. The "bottom-up" perspective of farmers and their felt needs were well articulated. Unfortunately, it failed to recognize that generation of research is an important public good. To do so requires an appropriate infrastructure to generate and supply the technology. The infrastructure in turn requires a political power base which actively supports and fosters such a thrust. Such a base is non-existent in many third world countries.

Failure of these models contributed to a number of introspective studies of such projects as Comilla in Bangladesh, CADU in Ethiopia, Puebla in Mexico, and Caqueza in Colombia as reported by Jon R. Moris in his thorough context book, Managing Induced Rural Development, 1981. Additionally, selected individuals working independently, including Collinson, Norman, Harwood, and Hildebrand, began to address ways for overcoming deficiencies of the land grant model. The result was a convergence of perspectives across a broad range of disciplines to go beyond a single commodity focus and embrace the full complexities of a third world farm system (Byerlee, Harrington, et al.; Dalrymple). This is in stark contrast to specialized U.S. agriculture of the 1970's and more like what U.S. agriculture was prior to WWII.

A number of other truths emerged from these efforts which are important for us to fully appreciate FSR/E evolution. Collinson's work in Africa in the 1960's and 1970's identified several methodological deficiencies of technical assistance research in LIC's. They are:

1. No clear target exists from which to launch micro-level research as researchers do not know the characteristics of LIC farmers, hence, have no basis for understanding them and their problems.

2. The state-of-the-art in conducting micro-level research in LIC's is very low or non-existent.

3. Institutions providing the research/extension services in LIC's are isolated from the farmer as the primary client.

4. The research, teaching, and extension functions typically are isolated from each other as autonomous and independent governmental, parastatal, and university components.

The work by CIMMYT, IRRI, IDRC at Caqueza, and others during that same time period contributed the following additional knowledge about LIC's (Byerlee and Briggs, IRRI, Conklin, Zandstra):

1. The bloom was off bio-technical research after the Green Revolution had blanketed the irrigated land of the third world. Moving to the remaining 85 percent of the non-irrigated rainfed uplands was posing far more serious challenges.

2. As T.W. Schultz had said a decade earlier in his book Transforming Traditional Agriculture, peasant farmers are rational economic men just as anyone else. Thus, a necessary condition for introduced technologies to be adopted is that they must be economically superior to what the farmer is now using.

3. Experiment station results provided unrealistic production targets as they did not reflect or take account of the conditions under which farmers produce. The non-reporting of yield trials because they "failed" due to frost, adverse moisture, insect infestation, stray cows, etc., actually threw out much of the information which is key to LIC experiments as they are precisely the variables farmers must contend with.

4. Capital is the most scarce resource. Yet, most introduced biotechnology requires that it be purchased in the marketplace. The level of cash input required relative to the income generated may serve as an important constraint to adoption.

5. We are more conscious of considering the potential economic and social consequences of technology adoption on different target audiences concerning equity, income impact, and employment.

Emergence of FSR/E as an Operational Methodology for Technical Assistance

The circumstances described provide the backdrop from which FSR/E emerged. It grew from an initial descriptive phase designed to obtain information for researchers about actual farming systems used by small peasant farmers in different parts of the world (Collinson and Harwood). This may be called the initial observation phase. Many current projects operating under the FSR/E label fall into that category. A detailed description of the evolutionary stage which different international agricultural research centers (IARC) are at is provided in the Gilbert, Norman, and Winch monograph "Farming Systems Research: A Critical Appraisal," 1980. Such procedures have yet to be operationalized by an organizational mechanism to implement the FSR/E model. This is where we are today.

It is recognized that FSR/E will have to be integrated into already established experiment stations, extension, credit, marketing, and university units as the operational model in LIC's and not as an add-on to already overloaded programs. That phase is being attempted now, on largely a pilot basis, with a substantial number of national agricultural programs in LIC's. They are sponsored by a number of international donors including IDRC (reported by Zandstra) and USAID. The USAID projects with which I am familiar that embody a FSR/E thrust all have been initiated since 1979. They include EMCIP (Egypt Major Cereal Improvement Project), Tanzania, Honduras, Botswana, Lesotho, Gambia, Sudan,

and Zambia. USAID has approximately 12 country-focused operational FSR/E projects plus a centrally funded USAID project being initiated this year. While it is clear from the CGIAR/TAC report in 1978 that a consistent body of FSR/E body of methodology has not developed across the IARC's, there are enough common characteristics to report (TAC). All of the USAID projects embody, or attempt to embody in various degrees, the following operational FSR/E components (Gilbert, p. 2; Whyte, p. 80; Harrington, p. 30):

1. The farm is viewed in a comprehensive manner by a multi-disciplinary research team. The focus recognizes that multiple crop, livestock, off-farm employment, household and consumption activities exist, are interrelated, and bear upon family welfare. (The physical/biological roots of IARC's generally neglect firm/household, macro-policy and distribution issues. (Johnson))

2. Research includes both development (up-stream) research at experiment stations and adaptive (downstream) research on farmer fields. (Some USAID and IARC projects do not yet embody this component but have been encouraged by TAC to do so.)

3. Researchers and farmers are joint participants to the decision process for identifying and prioritizing research projects. (An identified need yet to be implemented in USAID and IARC projects.)

4. Farmers' relative resource endowments and resource adjustment potentials are taken into consideration in establishing research priorities.

5. Local farmer and citizen groups serve as resource paraprofessionals to facilitate the adaption phase and assess the economic and social acceptability of introduced technology at the village and community level. (An identified need yet to be implemented in USAID and IARC projects.)

6. A distinct set of operational field procedures for research (Collinson, pp. 11-26; Norman, p. 6; Gilbert, p.11; Shaner, pp. 5-6; Harrington, pp. 21-30; Conklin/IPPC; Rohrbach, p. 7):

   a. Descriptive or Diagnostic Phase for Hypothesis Formulation.

      (1) Target and research area selection (recommendation domain).

      (2) Collect background information.

      (3) Conduct exploratory (informal) survey.

      (4) Conduct (formal) verification survey (2, 3, and 4 are combined with Hildebrand's sondeo approach).

   b. Technology Design Phase

      (1) A range of alternative technology strategies are identified by research team and farmers.

      (2) Strategies are prioritized on basis of technical, economic, and social feasibility, research criteria, and farmer "felt needs."

(3) Experiment station trials.

(a) Technology screening.

(b) Primary experiments (de-emphasized with some "downstream" research).

c. Technology Testing Phase

(1) Researcher managed trials.

(2) Farmer managed trials where he makes all decisions, bears all costs, and reaps all benefit (losses).

(3) Monitoring for technical and economic improvement and adoption potential.

d. Extension Stage

(1) Verification of whether the technology is acceptable to area farmers generally.

(2) Dissemination of new technology and information associated with it.

Operational Gaps: And Suggestions for Overcoming Them

FSR/E is being tested as a research methodology in a substantive number of countries with promising results. However, we should be careful not to view FSR/E as a panacea or an altogether new research methodology. Rather, it is a means for improvement of existing agricultural institutions by incorporating the small farmer and his conditions into the research process. Nor can it be viewed as all encompassing. It is micro in nature, so must be supplemented with macro research on political, economic, and institutional issues (Gilbert).

Within the micro setting for which FSR/E was intended, this author believes a number of methodological and organizational deficiencies remain which require clarification and remedy. The purpose here is to identify those issues for further discussion at this conference and hopefully to initiate dialogue on possible means for resolution.

The FSR/E literature does not contain a clear statement of the purpose of the field operation steps for FSR/E just listed. Rather, they are expressed in mechanical terms to facilitate training of project personnel and to gain researcher understanding of complex farming systems (descriptive analysis). Very limited thought has been given to prescriptive analysis of how to develop and adapt economically superior technology which will be adopted by LIC farmers (Gilbert, pp. 121-2). To accommodate the latter need will require, in my judgment, a much heavier dose of production economic analysis than currently exists, using economic tools which have been well honed in the U.S. but have not been used by international researchers.

For starters, permit me to list the functions which I perceive the plan of work for FSR/E field methodology should embrace:

1. A mechanism for technical and economic evaluation of specific technologies currently used by farmers which the introduced technology is expected to replace. The purpose is to establish comparative (opportunity cost) benchmarks against which the introduced technology must shoot for and exceed in order to have any potential for adoption. (No FSR/E methodology that I know of yet employs this component.)

2. A mechanism for establishing research project priorities utilizing both farmer and multi-disciplinary research team input into the decision process. The FSR/E literature expresses this need, but nothing on how to resolve it. To answer requires a means which identifies technically researchable, cost-effective, and time-oriented research choices are perceived by the researcher and felt needs from the farmers' perception. Both perceptions are combined and prioritized by a multiple factor ranking mechanism, which weight the choices. The process itself needs to be formalized, but not necessarily the methodology, per se, since limited data forces heavy reliance upon researcher judgment.

3. A mechanism for continuous screening of introduced technologies by technical and economic criteria at experiment station and farmer field sites:

   a. For eliminating technologies which hold out little economic promise for adoption.

   b. For modifying promising technologies by suggested farmer and research changes to enhance their potential for adoption in the farmer field trials.

4. A mechanism to measure level of actual economic gain associated with general farmer adoption. The purpose is to identify the economic premium required and ultimately the components (risk, resource use availability, cash cost levels, etc.) which influence it.

5. A mechanism to measure broader village and community acceptability on economic and social grounds.

Each of the five mechanisms which have been outlined embody implicit micro-economic principles which deserve clarification.

Let us start with the comparative benchmark of what farmers are doing now. Why is this important? Well, farmers face a wide variety of decisions each year ranging from when to plow, what variety of seed to plant, whether to fertilize or not, at what levels, what pesticides to spray and when, when to harvest, what and how to store, etc. What is important is that each decision poses unique cost/return relationships in an ex poste context and non-unique or probabilistic relationships in an ex ante decision context. For simplicity, the ex poste situation will be the focus of this paper. On the cost side, each decision poses two specific cost components representing (1) purchased and non-cash family costs and (2) opportunity cost for use of the resources for other purposes. The return side reflects an expected return or benefit from the decision(s). The cost/return relationships for such decisions can be ranked or ordered. They may include not only field decisions, but also family activities such as family

consumption, off-farm work, social activities, schooling, etc. Note that this embodies farmer rankings within the scope of the entire set of family decisions which are made.

To improve the farmer's lot from a production perspective requires that introduced technology be better than what the farmer is already using. Permit me to use an example to illustrate this point (Conklin). A traditional criolla variety of barley is grown by farmers in Tiraque Valley, Cochabamba province, Bolivia. It has a seed cost of $320 pesos/hectare and produces about .9 metric tons of grain/ha at $2900 pesos/ton, and 2.6 metric tons of straw at $1200 pesos/ton, for a total value of $5730 pesos/ha. No fertilizer or pesticides are used. The incremental (marginal) cost is $320 and the incremental (marginal) return is $5730, resulting in a benefit/cost ratio of $5730/320=18.1. In 1978 a higher yielding and yellow stripe, fungus resistant barley called Promesa was introduced for testing. Promesa produced an average of 2 tons/ha of grain and 3.3 tons of straw for a total value of $9760 pesos. The cash cost (seed only) was $420 pesos. Again, no fertilizer or pesticides were applied and the family labor requirement was the same as with the criolla variety. The resulting B/C ratio was $9760/420= 23.1. Promesa was more profitable per unit of capital than the traditional variety plus it was less risky by its stripe fungus resistance. By 1981 every farmer in Tiraque valley had adopted Promesa.

A contrasting situation exists in a neighboring valley called Valle Alto, where wheat is grown. It is a more marginal rainfall area than where barley is produced and of higher elevation. An Australian wheat variety well adapted to the area is the principal grain produced. It produces .3 metric tons/ha at $3580/ton and a straw yield of .4 tons/ha at $750/ton for a total benefit of $1374. Total cash cost was $60 pesos for the seed. The resulting B/C ratio was $1374/60=23:1. A short stemmed CIMMYT variety called Sapsucker is well adapted to the area. The AID Mission and Government of Bolivia (GOB) have encouraged adoption of the new variety. It produces about 2.3 tons of grain/ha and 1.2 tons of straw/ha for a value of $9134 or 6.6 times more income than the Australian variety now grown. However, Sapsucker produced well <u>only</u> with high fertilizer rates and weed control with 2, 4-D. Associated cash costs for such marked purchased inputs were $3200/ha resulting in a B/C ration of $9134/3200=3.3. Note that the incremental (marginal) cost of growing the new wheat variety increased at nearly the same rate as the value of increased yield. This was further exacerbated by a high yield risk in poor weather years. To this day, not a single hectare of Sapsucker variety wheat has been planted in Valle Alto.

An important economic principle is presented in the contrast between the two valleys in Bolivia. The question is not whether criolla and improved wheat varieties are profitable. They both meet that criteria. What is economically relevant is the concept that economists call opportunity cost or equa-marginal returns, in which farmers will select that choice which will earn them the <u>most</u> money given the extremely limited cash resource base they have. That choice in Valle Alto was to stay with the Australian wheat variety. If we had economic information from Valle Alto farmers on their potato crop and livestock operations, I suspect that we would find B/C rations well above 3:1 for them as well. In Tiraque Valley the opportunity cost favored adoption of the new barley variety. Note that in both situations the cash input expended was very low.

Clearly, researchers need to know what the B/C ratio is for the major points of decision that farmers make. This will supply a range of ratios which would serve as a generalized benchmark target for which to strive with introduced

technology for the target group. Anything less means no adoption; anything more we do not know until adoption takes place. That is, the additional bonus for risk, etc., is not known until adoption occurs and researchers measure the level. Now here is where homogeneity of the target group or recommendation domain becomes important. The B/C ratios are affected by level of physical input and its associated cost and the level of physical output and its associated cost. A change in any of those four factors among farmers change the B/C ratio.

To date, the FSR/E literature has provided very limited economics for inclusion in FSR/E operational methodology. The article by Byerlee, Harrington, et al., stated that "Possibly the area where (FSR/E) methodology is least developed is in the use of information on farmer circumstances to select the technological alternatives for experimentation." Economic analysis in the FSR/E literature has been limited to the CIMMYT Economics Training Manual. That manual describes the following types of economic analysis used by CIMMYT (Perrin, Byerlee, Shaner):

1. Partial budget analysis of alternative treatments from experiments.

2. Marginal analysis across treatments and several experiments to rank the marginal rate of return (B/C ratio) of each choice (dominance analysis).

3. Minimum return analysis to compare across treatments for price and yield variability.

4. Sensitivity analysis across treatments for price and yield variability.

Note that all comparisons are made with the <u>introduced</u> technology. No linkage is made with the farmer and his economic circumstances. While the analysis is excellent for preliminary economic screening of experimental alternatives, it does not provide a mechanism for linkage with farmer choices. What has been described in this paper is intended to provide that bridging mechanism to serve the following essential functions:

1. To provide a range of critical farmer decision points to serve as threshold targets against which (a) introduced technology is judged for suitability, and (b) the opportunity cost levels of actual adoption are measured to identify the adoption premium and ultimately the factors which contribute to it.

2. To clarify the importance of an individual versus a package of practices approach (experience in Turkey by CIMMYT indicates that single inputs are adopted in order of opportunity cost rather than as a package (Byerlee, Mann)).

To date, no one knows what the incremental return premium, if any, must be to get farmers to shift from their present technology to the introduced technology. The CIMMYT manual suggests a 20-50 percent incremental return premium which they ascribe to risk. Some have suggested B/C ratios of 2 or 3 to 1. Other researchers have suggested the physical doubling of yields. None have served as reliable guides. The Bolivia research reported suggests that the B/C ratios guidelines may be far too low for general use in LIC's and that the ratios in excess of 20 to 1 under conditions of extreme capital shortage may be more realistic.

Such high B/C ratios in LIC's may startle those of you who are familiar only with U.S. agriculture. Relative capital abundance in the U.S. has driven the Marginal Return of capital down to a rate nearly equal to its marginal cost, which is the external interest rate for borrowing capital. But this was not always the case in the U.S. Our capitalistic system in its formative years was the outgrowth of an environment in which capital was very scarce such that improving the efficiency of capital was beneficial. Over time capital became more abundant, and with it the U.S. developed refined public and private financial institutions including lending agencies for farmers. Since WWII, farmers have had only to prove that earnings exceeded the cost of capital to obtain loans. Farm management extension shifted to applications of micro-economic theory and quantitative methods to demonstrate that new technology paid. Such is not the case in LIC's. Their capital is so scarce that the Marginal Return in alternative decision choices are equated internally (on the farm) across all alternative uses rather than with an external capital cost rate. Additionally, the physical and biological conditions in LIC's generate a more variable set of uncertain outcomes than in the U.S. The contrast can be expressed using the concept of a production function and marginal analysis found in any modern farm management text.

**[Figure missing in original document]**

Total revenue on the graph represents a yield or response function per acre expressed in monetary terms from the use of varying levels of input shown on the horizontal axis. The $MR_1$ level exemplifies the capital scarce conditions in LIC's while the $MR_2$ level exemplifies the capital abundant condition of the U.S. where $MR_2$ $MC_2$ external capital interest rate. Unfortunately, the conduct of considerable research in LIC's is in the $MR_2$ region of the response function, a region totally unattainable for LIC farmers with scarce capital.

One final economic issue is worth mentioning here. Conventional wisdom in international agricultural development literature states that the LIC farmer practices risk avoidance. Yet, there is an increasing body of information which does not support that contention. Rather, it suggests they practice "flexibility," which reflects risk aversion for some types of decisions and risk taking for other types of decisions (Whyte, p. 28; Zandstra, pp. 201-4; Ortiz, p. 276; Johnson). If this is true, and I believe that it is, then we need to pay much closer attention to the farmer's opportunity cost levels for each of his major decision points to use as initial threshold targets and divert our risk work to finding out what types of decisions fall into the "risk aversion" versus "risk taking" categories.

In closing, I believe that methodology development for FSR/E is moving in the right direction and shows considerable promise. It provides an operational methodology which simply did not exist with the earlier U.S. land grant model applied to LIC's because it assumed erroneously that U.S. technology was superior, and hence, would be adopted wholesale. Unfortunately, FSR/E to date has been preoccupied with trying to understand complex farming systems world-wide. As a consequence, it has overemphasized ex poste extensive whole farm surveys and under-emphasized ex ante farmer decision making. In the process, economic analysis (both description and prescriptive) was ignored. My thesis is that now we should incorporate micro-economics into FSR/E, especially that which examines opportunity cost levels of major farm decisions. While micro-economics has its own flaws (static, risk-less, non-distributive), it is sufficiently robust to address the problems described herein.

FSR/E has advanced to where we are nearing embracement with LIC farmers. I urge that they become full partners in this experiment. We need their perspective to help solve their problems. In so doing, perhaps we, like Franklin, may be surprised that they will make men of us.

## REFERENCES


AID Mission/Botswanna. 1981. Project Paper. "Botswanna Agricultural Technology Improvement."

AID Mission/Egypt. 1979. Project Paper. "Egypt Major Cereals Improvement Project."

AID Mission/Gambia. 1981. Project Paper. "Gambia Mixed Farming and Resource Management Project."

AID Mission/Lesotho. 1978. Project Paper. "Lesotho Farming Systems Research."

AID Mission/Sudan. 1979. Project Paper. "Western Sudan Agricultural Research."

AID Mission/Tanzania. 1982. Project Paper. "Tanzania Farming Systems Research."

AID Mission/Zambia. 1980. Project Paper. "Zambia Agricultural Training, Planning and Institutional Development."

Bradford, Lawrence A., and Glenn J. Johnson. 1953. Farm Management Analysis. John Wiley.

Byerlee, Derek, Stephen Briggs, et al. 1979. "On-Farm Research to Develop Technologies Appropriate to Farmers." Presented at Conference of the International Association of Agricultural Economists, Banff, Canada.

Byerlee, Derek, Michael Collinson, et al. 1980. "Planning Technologies Appropriate to Farmers, Concepts and Procedures." CIMMYT, Mexico.

Byerlee, Derek, Larry Harrington, and Donald L. Winkelmann. 1982. "Farming Systems Research: Issues in Research Strategy and Technology Design." Invited Paper for AAEA meetings, Logan, Utah. August.

Castle, Emery N., Manning H. Becker, and Frederick J. Smith. 1972. Farm Business Management, The Decision Making Process. Mcmillan Company. 2nd edition.

CID/NMSU. 1982. "Proposal for Honduras Agricultural Research Project."

Collinson, Michael P. 1982. "Farming Systems Research in East Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976-81." International Development Paper Number 3. Department of Agricultural Economics, Michigan State University.

Collinson, Michael P. 1972. Farm Management in Peasant Agriculture: A Handbook for Rural Development Planning in Africa. Praeger.

Conklin, Frank S. 1982. "Economic Work Plan and Supplement" IPPC/OSU/USAID Weed Technology Project for Contract Period 6/1979-6/1982.

Conklin, Frank S., and David W. James. 1982. "End of Project Evaluation for the CID/Bolivia Contract on Basic Foods Production and Marketing." October.

Dalrymple, Dana G. 1971. Survey of Multiple Cropping in Less Developed Countries. FAER 91, ERS, USDA. October.

Doll, John P., and Frank Orazem. 1978. Production Economic Theory with Applications. Grid.

Forester, D. Lynn, and Bernard Ervin. 1981. Foundations for Managing the Farm Business. Grid.

Gilbert, Elon H., David W. Norman, and Fred E.Winch. 1980. "Farming Systems Research: A Critical Appraisal." Rural Development Paper Number 6, Department of Agricultural Economics, Michigan State University.

Harrington, Larry. 1980. "Methodological Issues Facing Social Scientists In On-Farm/Farming Systems Research." Economics Program/CIMMYT, Mexico. April.

Harwood, Richard R. 1979. Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics. Westview Press.

Hayami, Yujiro and Vernon Ruttan. 1971. Agricultural Development: An International Perspective. John Hopkins Press.

Heady, Earl O. 1952. Economics of Agricultural Production and Resource Use. Prentice Hall.

Heady, Earl O. 1979. "Micro-Level Accomplishments and Challenges for the Developed World" in Proceedings of 17th International Conference of Agricultural Economists. Banff, Canada.

Heady, Earl O., and Harold R. Jensen. 1954. Farm Management Economics. Prentice Hall.

Hildebrand, Peter E. 1979. "Summary of the Sondeo Methodology Used by ICTA."

International Rice Research Institute. 1978. Economic Consequences of the New Rice Technology. IRRI, Philippines.

de Janvry, Alain. 1981. The Agrarian Question and Reformism in Latin America. John Hopkins.

Johnson, Glenn. 1981. "Small Farms in a Changing World." Presented at FSR Symposium, Kansas State University. November.

Johnston, Bruce F., and Peter Kilby. 1975. Agriculture and Structural Transformation. Oxford Press.

Mann, Charles K. 1978. "Packages of Practices: A Step at a Time with Clusters." Middle East Technical University. Fall.

Moris, Jon R. 1981. Managing Induced Rural Development. IDI, Indiana University.

Norman, David W. 1980. "The Farming Systems Approach: Relevancy for the Small Farmer." Rural Development Paper Number 5, Department of Agricultural Economics, Michigan State University.

Ortiz, Sutti R. de. 1973. Uncertainties in Peasant Farming. London School of Economics.

Perrin, Richard K., Donald L. Winkelmann, Edgardo Moscardi, and Jock R. Anderson. 1976. "From Agronomic Data to Farmer Recommendations: An Economic Training Manual." Information Bulletin 27. CIMMYT, Mexico.

Rohrbach, David. 1981. "Issues in Developing and Implementing a Farming Systems Research Program." OICD/USDA. September.

Schultz, T. W. 1964. Transforming Traditional Agriculture. Yale Press.

Shaner, W. W., P. F. Philipp, and W. R. Schmehl. 1982. Farming Systems Research and Development: Guidelines for Developing Countries. A CID Study. Westview Press.

Sheppard, Wendy J. ed. 1982. "Proceedings of Kansas State University's 1981 Farming Systems Research Symposium - Small Farms in a Changing World: Prospects for the Eighties." Paper Number 2. April.

Technical Advisory Committee (TAC). 1978. Farming Systems Research at the International Agricultural Research Centers (CIAT, IITA, ICRISAT, and IRRI). TAC/CGIAR. September.

Timmer, Peter C. 1972. "Employment Aspects of Investment in Rice Marketing in Indonesia." Food Research Institute Studies. Volume XI., Number 1.

USAID, Office of Agriculture. 1982. Project Paper. "Integrated Systems for Small Farmers: Farming Systems Research and Extension."

Whyte, William F. 1968. "Models for Building and Changing Organizations" in Human Organization. Volume 26, Numbers 1-2, pp. 22-31.

Whyte, William F. 1981. Participatory Approaches to Agricultural Research and Development: A State-of-the-Art Paper. ARE Number 1. Cornell University.

Wittcowski, Edward, and Arnold Wells. 1979. Economics of Agricultural Production. Alfred Publishers.

Zandstra, Hubert, Kenneth Swanberg, Carlos Zulberti, and Barry Nestel. 1979. Caqueza: Living Rural Development. IDRC, Canada.

# FSR PROJECT EVALUATION[1]

J. K. McDermott[2]

The first task in FSR Project Evaluation is to recognize or perhaps even to determine what we are about. Few movements in our business have generated as much enthusiasm and at the same time as much confusion, even controversy, as has Farming Systems Research (FSR), or as it is sometimes called, the "Farming Systems Approach" (FSA).

This confusion apparently does not exist among the professionals, judging from the discussions at this conference. The "Farming Systems" concept, however, has picked up a huge group of "camp followers." These non-professionals are attracted to the concept for a variety of reasons, reflecting the many facets of farming systems research. These many facets and their adherents lead to the diversity of interpretations of the term. The faddish nature of farming systems comes from the camp followers, not the professionals. There is a real danger that the enthusiasts will cause farming systems research to be looked upon as a fad, in which case it could go the way of all fads.

The very concept of systems is a bit tricky, since everything is eventually related to everything else. Thus, each practitioner has the right to define "system" for his own convenience.

Here is my definition, or conceptualization, of farming systems. There are two major definitions of farming systems research among practitioners.

One line of farming systems research deals with substance. The farming system per se is the dependent variable. The objective is to develop one or more new systems of farming as alternatives to the systems currently being used. The worry over cropping systems as opposed to total systems has little meaning. If you change the cropping system you have changed the farming system.

The second line or category of farming systems research emphasizes style, process, or approach. It seeks to understand the farmer and his system and to generate technology innovations that are relevant and appropriate to that system. This line of work does not seek to replace current systems or even make major changes in them. Over time, of course, as innovations accumulate the system will change.

Some researchers interested in the system as the dependent variable come to terms with farmers and their environment, i.e., they tend to adopt the farming system style or process as they deal in substance.

Evaluation is a tough job under the best of circumstances. Project evaluation is far removed from the best of circumstances, as is research.

---

[1]Prepared for Farming Systems Research Symposium, Kansas State University, November 21-23, 1982.

[2]Program Officer, International Agricultural Development Service (IADS).

It is my thesis that the major potential contribution of FSR lies in its power to perfect the state of the art in managing the technology innovation process in agriculture, and that FSR must be evaluated against that end. For this purpose, style or process is particularly valuable. It is my fear that we could miss this opportunity, exactly because we do not recognize what we are about. This paper intends to explain and defend these assertions.

In the Farming Systems Approach we are dealing with a total process which can be called technology innovation. Technology innovation is as old as civilization. In fact, it may be what civilization is. Only very recently, in historical perspective, have we invented social machinery with the explicit and specific purpose of accelerating the natural technology innovation process, if human endeavor can be called natural. In almost all cases this contrived social machinery consists of a research entity and an extension entity. It is to these entities we look to manage the acceleration of the process. Who they are and what they do to determine, country-by-country, how well we are going to perform in accelerating the pace of technology innovation. Much has been learned under the general rubric of FSA to help us manage technology innovation.

The technology innovation process can be crudely visualized by Figure 1. This figure attempts to identify the critical events of the process and to place them is some kind of sequence. The simple chronology is a vast oversimplification of the sequence of these events, but it has some validity. It attempts to distinguish between science and technology, it identifies four activities within technology development, and it indicates that some sort of sequence is important. Although this chronology is oversimplified, it characterizes to a considerable extent the image many development workers have of the process. This image implies that all innovations start with research, that extension performs a mechanical function of transmitting whatever research provides, and that the farm sector is something of an inert mass to be moved only by external forces.

Figure 1. The Technology Innovation Process

| SCIENCE | | | TECHNOLOGY | | | | |
|---|---|---|---|---|---|---|---|
| Basic Research (Pure, Theoretical) | Applied Research (Practical) | Tech Develop-ment | Tech Testing | Tech Adapt-ation | Tech Inte-gration | Tech Dif-fusion | Tech Adop-tion |
| Research (R&D) | | | (Technology) Development | | | | |

I am an unabashed apologist for the U.S. tradition-commonly exemplified by the Land-Grant College System. That is a great pragmatic system. It has been highly productive in serving our own needs. However, we have not done our homework in conceptualizing it. Which is to say that even though we did it very well, we never did really know what we were doing. It's sort of like driving a modern automobile. Very few of us know what all is happening in the functioning of today's automobile. Yet we are really quite good at using it to get exactly where we want to be. The analogy is a good one. At home we are operators of machinery, in our overseas development projects we are literally engineers and mechanics of the social machinery that sustains the technology innovation process. We are not just operators of the machinery. We must know how to design it and tinker with it when it doesn't quite work right.

Several mistakes are now apparent in retrospect. One is that we did not distinguish in agriculture between science and technology. The second is that we attempted to use as concepts the words, “research" and "extension," which in our own situation were used essentially as labels of two arbitrary administrative forms. As concepts they have no power to cause problems. The major problem is that they have led us to divide up the technology innovation process into clean cut, clearly marked, and clearly separated segments and to call one research and the other extension.

If we study this Figure 1 a little bit, we can see that on the left side are about three blocks that can be clearly distinguished as research. On the right is a block that can be clearly distinguished as extension. In the center are three blocks that constitute a kind of no man's land, and in retrospect we can see that for years we avoided it. Our assistance efforts in research emphasized the Ph.D. and scientific norms. Our efforts in extension for years were confined to the field agent. The typical structure that we caused to be set up in many countries was not in our own image.

A second conceptual lapse has been our failure to distinguish between science and technology. Science cannot be judged on its usefulness. There is no other way to judge technology. Farmers use technology, not science. Distinguishing between science and technology does not indicate an anti-science bias. This conceptual lapse also led us to ignore the middle section of the technology innovation process.

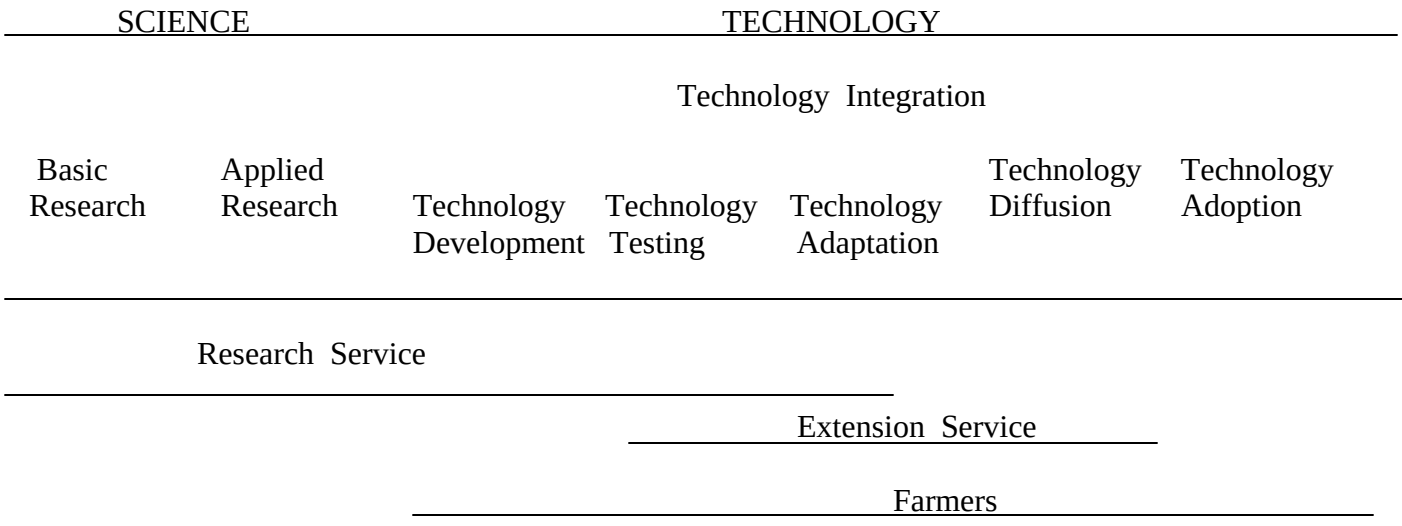
A third conceptual error is the lack of appreciation of the farm sector as a dynamic social system actively seeking better ways of doing things. Conceptually, in the U.S. Land-Grant tradition, we have emphasized "resistance to change," while pragmatically we have taken great advantage of an authentic and powerful drive to find better ways of doing things. Pragmatically, we used the demonstration as one of the most powerful extension methods. We also identified the phenomena of the innovator and the early adopter. Our research showed that most farmers learned of new technologies from other farmers. Conceptually, however, we did not appreciate adequately the urge to innovate, the experimental nature of the farmer social system. We did not see the demonstration as a great accelerator or facilitator of the farmers' own experimentation process. Pragmatically we dealt very well with the facts, with the real world, but conceptualized the farmer as virtually an inert, passive mass that would only be moved by public agencies. This may be a bit of an exaggeration, but it is not much. The current T and V system, with its ratio of farmers to extension worker, is a powerful residue of that conceptual error.

Farming Systems Research has occupied the middle ground. It deals with testing, with adaptation, and with integration. And it replaces the simple chronology with an interaction between the farmer social system and the publicly supported social systems invented to help the farmer with technology innovation.

Figure 2 helps visualize the process a little more in accord with our needs. Integration is an important concept. Just as new knowledge (from science) must be put together with other things to produce a technology (something useful), that technology must be fitted in with all the other technologies which constitute the farming system. There is no way research and extension can help with this integration into the farming system without a close interaction between the public agencies invented to accelerate technology innovation and the farmers who have

the last word on technology innovation. The only alternative to this interaction is to leave the integration function to the farmers, with no help from the technology innovation system.

Figure 2. Entities Involved in Technology Innovation Process




Farming Systems Research has occupied the middle ground and has performed quite well. What remains to be done is to fit into the structure, and that will be a tough job. It is my anticipation that in the long run FSR will be evaluated on how well it achieves this next step. As long as we have the research-extension structure in most countries, we are going to have to deal with it--even if dealing with it involves replacing it.

Two points need to be made.

1. One deals with process, specifically the distinction between research and extension. Before farming systems research, those two ends of the process were so widely separated that we never had any trouble telling them apart. They were so clearly distinguished that the process simply fell apart. The historic non-linkage between research and extension is clear evidence of this separation. One of the attributes of farming systems research is that the dividing line between research and extension becomes blurred--in fact is not a line at all. Sometimes regarded as a "problem," this may be one of the really strong points of farming systems research. There is another "blurring" that needs to take place. We may be tempted to distinguish between so-called upstream and down stream research, or between systems research and component research. I hope you don't let it happen. If farming systems research does serve the technology innovation process, the lines must stay blurred. If that is redundancy, so be it. Better redundancy than gaps in a vital process. If farming systems lives up to its promise it will do "Extension" at times and "Component Research" at times--and maybe both at the same time.

2. The second point deals with simplicity. In several contexts, farming systems research practitioners deal with complexities. Much of the talk that surrounds farming systems research deals with complexity, noting particularly the comprehensive or holistic approach and the multidisciplinary teams. Many of our farming systems research projects

are in countries where the resource constraint is exceptionally severe. Just as farming systems research must come to terms with the farmer and his resource constraints, farming systems research projects must come to terms with the less developed countries and their resource constraints. Thus, we need a conceptualization of farming systems that will serve from the very simplest to the most complete situation.

Stripped to its barest essentials, farming systems research is composed of two components, which can be thought of as the two ends of a circle. See Figure 3.

Figure 3. The Two Ends of a Circle Concept of Farming Systems

**[Figure missing in original]**

Farming System

At one end of the circle, the researcher knows and understands the farming system. At the other end of the circle, innovations he proposes must be (a) tested in that system in which they are expected to perform, and (b) by the criteria of that system. It simply is not necessary to know everything about that system. You know as much about that system as is feasible with your resources. It is likewise not necessary to deal with the whole system. You deal with that system to the extent your resources will allow. It is necessary that whatever you do is compatible with that system. As someone has put it, "Don't violate the system." ICTA in Guatemala is an entire research agency organized by the farming system style. It deals almost exclusively with the food grains, neither with livestock nor other cash crops. It is multi-disciplinary, largely to the extent that many of its B.S. and sub-professional personnel have not had the opportunity to specialize. These non-specialists are supported by specialists, but the group is small and does not include many specialties.

Criteria of the farming system is important. If straw is an important product of the barley crop (Syria) and of the rice crop (Thailand), plant breeders must use that criterion in evaluation varieties, and that criterion will include palatibility and digestibility, as well as quantity. If farmers must get a rice crop off to make way for mustard, varietal tests must include how well the mustard does. Testing in the system by criteria of the system will broaden the scope of research. The barley breeder concerned with quantity and quality of straw is dealing with the livestock component of the system.

What criteria are important, then, in evaluating FSR? In my judgment, FSR must be evaluated on its demonstrated impact and its probable impact on the structure and function of the social machinery surrounding the technology

innovation process. The process per se is an abstraction. It can only be visualized in the mind. Structure and function are concrete. There are definite entities--specific persons occupying specific positions in specific social systems. Each of these social systems has access to a specific set of resources and is authorized to do specific things. It is also specifically not prohibited from doing other specific things. These specific entities, their resources, and their assignments constitute structure. These persons in the social systems are engaging themselves in specific actions and concerning themselves with specific thoughts. All of these things can be observed, although in many cases not very easily.

The time frame of a project is too short to accomplish a definitive evaluation from observation alone. It is necessary to deal with the probability of persistence, or some expectation of the future, as well as empirical observation of the current situation. This state of affairs brings us to the need for inferences, and maybe we are beyond the margin of dependable evaluation. Inferences are indeed difficult and tentative. Yet we are forced to them. If we do not make them systematically, they will be made intuitively and whimsically.

Impact on the farmer and the farm sector has two shortcomings as a criterion for evaluating an FSR project. One is that the time frame of a project is almost always too short for the impact of a project to work itself out. The second is that a project always involves external resources, both financial and monetary, and in the short run it is difficult to relate impact on farmers with the probable persistent impact on the social structure and function surrounding the technology innovation process.

On the other hand, impact has some advantages even if somewhat aided by external forces. Impact gives visibility which may be possible to convert into support. Impact also gives host institution personnel a taste of success or achievement which may be useful in conditioning the total process.

If farming systems research is to be evaluated in terms of its impact on the technology innovation process and on the structure and function of the social systems which must support the process, then we can use some of the institution building concepts in evaluation. In that system, two sets of variables are important--the institutional variables and the linkage variables. There are five institutional variables--doctrine, leadership, resources, structure, and program. There are three important linkage variables--with the farmer, with extension (and other entities needed to accomplish the mission), and with government. These will be discussed separately.

Doctrine is the attitude or mentality that characterizes the personnel of all institutions or organizations concerned with technology innovation. A functional doctrine will include a respect for farmer (or client), wisdom, and a willingness to interact with him. It will also include a sense of service to the farmer, a recognition that the farmer has the last word technology innovation, and that the research and extension services exist solely to facilitate his work.

Leadership refers not only to those who are in authority positions, but also to those elsewhere in the organization who have or could have influence. There is a limit, of course, on what a project can do for leadership. Cause and effect are often in the opposite direction. However, a successful project can sometimes generate a degree of self-confidence that will encourage a latent leadership ability to manifest itself. The strengthening of leadership can be

a positive item in evaluation. Often its absence cannot be regarded as a negative.

Resources is not a good measure of project success in the short run. This variable is important with regard to project design, and the central question is whether the design is consistent with the resource base. It is common for projects to be designed beyond the capacity of the host institution to sustain. In the longer run, resources available to an organization may be one indicator of the efficacy of enabling linkages, discussed below.

Structure commonly refers to the structure of an institution. In farming system evaluation, the critical factor is how the project is designed with respect to the structure of the host institution. If it is designed as a separate unit, or very much apart from the host institution, the chances of its having an impact on the total process are quite reduced. Such separatism shelters the project from hostile elements and makes for a "neat and easy" task but does not take long run institutional needs into consideration.

Program refers to what the institution actually does. It is not difficult to judge what the farming systems effort per se does. You have to look a little deeper to find what the institution does as a result of the farming systems research project. The measure of what it does will depend on how the farming system effort is related organizationally to the rest of the technology innovation system. What the institution does will also reflect--or can be used to reflect--how well its personnel have learned methodologies from the project. It's a difficult task to separate out the contribution of the expatriate team from the total effort in order to identify "what the host institution does."

Linkages are another set of important products of a farming systems research project. The most fundamental of these linkages are those with farmers. In fact, linkage with farmers is almost an identity with farming systems research. Unless there is no effective farming systems research. The testing in the farming system is likely to be more important than the original understanding of the system. Interaction with the farmer can be greatly facilitated by the on-farm (or in-the-system) testing, and especially so if system criteria are used. Learning these criteria takes the researcher a long way toward understanding the system. It should be recognized that "feed back" in one cycle is "feed forward" (or feed front, or pre feed) for the subsequent cycle.

Linkage with extension is highly important, even if it cannot be called fundamental. There are many products of this linkage. One is training of the extension worker. The other is the multiplication of efforts of the researcher. Extension in almost all cases has some personnel completely capable of helping out with on-farm trials, with need identification, and with result interpretation. This multiplication of effort can enlarge the scope of the technology innovation, by its being tested over a wider range of environments than research workers could do alone. The final product of this linkage is the improved chances for rapid diffusion.

Enabling linkage is the third type of linkage. It is not inherent in the farming systems research concept. Its utility comes in the chances the host institution has for survival and prosperity. Enabling linkages are those with the entities of government that provide both authority and resources to the host institution. Attention to these linkages needs to be built into projects. Without authority and resources and the management capability to take advantage

of them, a farming systems research project has greatly reduced chances for persistence. Project resources can easily mask this need.

In conclusion, farming systems research in the long run is likely to be evaluated on its contribution to the state-of-the-art in managing the total technology innovation process. It has the capability to provide some functions which are vital to the process but which are often lacking. As a fad, farming systems research is in danger of being oversold, not by the professionals but by the enthusiasts and those looking for the single solution. On the other hand, farming systems is being undersold as a vital component of a fundamental process which includes traditional or conventional research and extension. Farming system research project evaluation can well be done in terms of its impact on research and extension institutions.

# INTEGRATING PARTICIPANTS: FARMING SYSTEMS LESSONS FROM HAWAII

Carol J. Pierce Colfer
Hawaii Institute of Tropical Agriculture and Human Resources

The purpose of this short paper is first to provide a brief description of the genesis and early phases of the University of Hawaii's farming systems program. The stage is thus set for a discussion of our experience to date in integrating participants in farming systems teams. The relevant aspects of this experience include specific steps we took in anticipation of possible interdisciplinary teams.

## A History

In July 1981, a five member planning group formed to decide how to implement farming systems into UH's College of Tropical Agriculture and Human Resources. This interdisciplinary group was fortunate to include Dr. Perry Philipp, Co-author of the recent publication Farming Systems Research and Development: Guidelines for Developing Countries and an Agricultural Economist. All members were intensely interested in investigating this new approach that seemed to hold so much promise for making research relevant and usable by third world farmers of both sexes.

After three months of intense and lively weekly meetings, we planned a "Fall Farming Systems Forum" for 15 carefully chosen faculty members from 11 different disciplines. Group members came from extension, research, and instruction positions; they represented all of Hawaii's counties (including four islands); and the male-female ration was 3:2. We also incorporated four external resource persons who had been directly involved in one kind of farming systems approach or another.

That larger group met together for three full day sessions, spread out over three months. The meetings were designed to acquaint group members with the concept of farming systems. Other important goals included the development of at least one genuinely integrated, functioning, inter-disciplinary team, and an assessment of the appropriateness of farming systems for the Hawaii context. Our final activity for the total group was a two-day, overnight retreat in a secluded area outside Honolulu. During the retreat the forum group split into two action groups to plan spring farming systems mini-projects.

Recognizing that a full blown farming systems project could not be undertaken in a six month period, the two teams decided to conduct sondeo's (Hildebrand, 1979) in two locations. The "Sugar Team" focused on independent sugarcane growers on the island of Hawaii. This project was not atypical for a farming systems project, having considerable potential for technological solution. The "Waianae Team," which focused on families in a low-income area of Oahu who were involved in or interested in becoming involved in small scale food production, was more experimental, including many Human Resources faculty. The team members were prepared to accept a mandate for a project that required community or political action, policy changes, and other non-agricultural and non-technological "solutions."

The Fall Forum series had been coordinated and orchestrated by the planning group; but with the implementation of the spring projects, an attempt was made to "decentralize" and put leadership responsibility with persons chosen by the groups. The Sugar Team developed a dual leadership role with an agricultural economist working on the Oahu campus and an extension home economist providing local leadership on the island of Hawaii. The Waianae team chose two Human Resources faculty and an Animal Sciences researcher to co-lead their group. The planning group continued to play a back-stopping, advisory role; I continued to perform a variety of support functions (distributing relevant reading materials, memos, phoning people, arranging talks, and sending reminders).

The two teams conducted their sondeos and wrote reports to the College administration on their findings and recommendations for further farming systems action. Within the College Administration there had been unanimous support for continued farming systems activity, and there is considerable enthusiasm among team members to develop actual projects. The effectiveness of interdisciplinary communication among team members has been the source of a good deal of the enthusiasm that team members have displayed, both informally and in our formal evaluation session in July 1982.

Integrating Participants

In our farming systems activity, we had one advantage that is rare in the "real world" of farming systems projects: Those faculty members whom we approached had total freedom as to whether or not they wanted to participate. After our planning group had identified faculty members whose concerns and general approach seemed consistent with those discussed in the farming systems literature, I approached them with a brief explanation of farming systems R&D. I asked them if they would like to participate, contingent on their making a commitment to continue throughout the Fall Forum and the spring projects. The whole program has been organized within a philosophy that emphasizes the experimental nature of this kind of approach. We have urged faculty members to evaluate the approach themselves to see how it contributed or does not contribute to their own research and Development/ extension goals.

Within this context, we conducted three specific exercises that contributed substantially to our success at integrating the participants. We anticipated early on that interdisciplinary communication might be a significant problem, since each of the planning group members had already worked on a number of multidisciplinary* teams. We therefore first consulted Dr. Ada Demb, Assistant Director of HITAHR, who had been trained as a management consultant and had had experience with interdisciplinary groups, for advice on how best to sensitize the members of the Farming Systems Forum to the kinds of differences in perspective they could expect--and would have to adjust to--from their co-participants. She suggested using Kolb's (1971) "Individual Learning Styles Inventory," (see Appendix A) and administered it to the forum members at our first meeting. She plotted the results from our group on a graph, so that we could see clearly the variation in learning styles that existed among us. The graph has

---

*Gilbert, Norman and Winch make an important distinction between "interdisciplinary" and "multidisciplinary": "Multidisciplinary suggests involving several disciplines while interdisciplinary connotes the disciplines working together, rather than independently, in solving a specific problem" (1980:18).

a concrete-abstract axis and an active-reflective axis. Learning styles are characterized by accommodation, convergence, divergence, or assimilation--respective quadrants of this graph into which responses can fall.

We considered allocating spring project team members on the basis of these results, since the learning styles provide complementary advantages for a team; but ultimately we decided that enhanced motivation from the opportunity to self-select was more important than might be the more complementary intra-team learning styles. Dr. Demb's explanation of the kinds of differences in learning styles identified by the instrument served to sensitize forum members--many of whom had had no previous exposure to cognitive research--to differences that we would all have to cope with while working together.

An instrument that has been used by Dr. Joe O'Reilly (another of our planning group members--an ecological psychologist) to facilitate intra-team cooperation in another context is the Myers-Briggs Type Indicator. The Myers-Briggs places respondents on four continua: extraversion-introversion; sensing-intuition; thinking-feeling; and judging-perceptive. Appendix B gives a brief summary of the characteristics of each type identified by this instrument. We are seriously considering using this instrument as well as part of the orientation for our Tropsoils Farming Systems Team (discussed below).

The second specific technique that we employed was an exercise, planned and led by an anthropologist, Dr. Harold McArthur (International Program Coordinator at HITAHR, and Farming Systems planning group member), at our two-day retreat in January 1982. We had already divided into our perspective farming systems teams. Each team member wrote down, in a half an hour, what kinds of input he or she thought each other team member was likely to contribute to the project. These were then read aloud, and each person had the opportunity to comment on the expectations that other team members had. This served to correct inaccurate stereotypes, to broaden team members' views of other disciplines, and even to increase people's awareness of their own skills.

Our third technique was not so unique in farming systems R&D: The sondeo. This proved to be a very effective method for integrating participants and for dramatically illustrating the valuable input available from different disciplines. Our sondeos were shorter than the prescribed length of time (only four days each), but as training mechanisms they were excellent. As with the retreat, we found getting team members away from their offices, telephones, and day-to-day interruptions to be extremely valuable. The discussions with farming families, the interaction with members of other disciplines on interviews, and the sharing of findings and informal discussion that continued at meals and into the night were invaluable in a number of ways-- not the least of which was further integrating participants into a working team.

Having completed the year's activity (Fall Forum and spring projects), we are now well into our next two activities: Farming systems orientation for the Tropsoils Project, whose members are all here at this conference, and for interested members of the County faculty on the Big Island (Hawaii). The techniques discussed here will be repeated in both orientation programs with the major change being a shift away from theoretical discussions of farming systems as a conceptual framework into a more grounded approach. We think that tying the concepts more clearly into particular contexts will further facilitate intra-team interaction and cooperation.

The Tropsoils team will begin implementation of a five-year Soil Management CRSP project in West Sumatra in January, using a farming systems approach. Members of the Hawaii County faculty (extension, researchers, and specialists) have expressed interest in the potential of the farming systems approach for solving some of their local problems. In both cases, there are specific problems and actual or potential team members who can fashion their farming systems projects appropriately. The diversity of roles, existing commitments, and geographical location represented in last year's group precluded the kind of grounding that is necessary for actual project implementation.

Potentially Thorny Issues

As I have indicated, we have been generally pleased with our success in facilitating truly interdisciplinary collaboration to date. However, three important issues strike me as potential stumbling blocks for ongoing collaborative efforts.

The first relates to the definition and perception of what is good research. Members of our group come from disciplines where experimental research designs are considered essential, as well as from disciplines which readily accept very experiential kinds of research as legitimate. Although there was general recognition and acceptance from the beginning that these differences existed and were in fact valuable, we found it difficult to incorporate this cognitive acceptance into our daily thinking and discussion.

We found, for instance, that different members of our group had different understandings of what the term "data" meant. The soil scientists visualized numbers in a matrix as data; the anthropologists included unquantified generalizations based on repeated observations of behaviour as data. Some of these differences first emerged while critiquing each others' writings. In a similar vein, we learned that where the interactive aspect of farming systems is very consistent with some behavioural science approaches, it presents real difficulties for the preplanned research designs characteristic of physical and biological sciences.

There were also differences of opinion about the length of time that should be devoted to data collection and planning prior to beginning actual experimentation and farmer collaboration. A person who expects to fill a liaison role between farmers and researchers can begin quickly. A person who wants to incorporate an understanding of traditional time allocation in the community into an improved cropping system will need a bit longer before useful input can be provided. Similar variations exist in more strictly agronomic kinds of research: a new variety takes a while to produce; experimentation with a new cropping system can begin immediately.

The second important issue that emerged in our attempts to develop good team work was that of roles that team members were used to filling. Some team members found the initial phases of the Forum, in which we were discussing the farming systems conceptual framework, extremely exciting. They were interested in theorizing and conceptualizing, and they saw our discussion to be directly relevant to their professional interests and responsibilities. Other team members perked up only when we got into the specifics of how farming systems had been applied elsewhere and what particular contexts might be appropriate for applying or modifying the general concept. Still others only saw its relevance when we got to the point of action. These people were not excited by theory, but

rather by the prospect of action in community contexts. The above three responses correlated loosely, in my judgement, with primary roles in instruction, research, and extension, respectively.

The last issue that emerged was a difference in people's experience and expectations about interacting with farming families. Some, such as myself, were accustomed to interacting with farming families with the primary purpose being to understand the systems in which they were operating. Others, such as extension home economists, were used to approaching families with the intent to help them. Still others--e.g., "bench scientists"--were entirely unused to dealing with community members at all. The farming systems approach, as we have been using it, requires interaction, understanding, and helping. We all needed to alter and expand on our usual behaviour toward farming family members in some way or another. Explicit recognition of the expertise that existed in the group in working with farming families facilitated our success at sharing what we each knew and coming to recognize what we did not know.

A Personal View

As Coordinator of these activities, I developed some opinions about how farming systems should be organized. Since many of these views are relevant for genuinely integrating participants, I put them forth here.

Decentralization of decision making - The enthusiasm that forum members appear to feel for their participation in this program derives in large part, I believe, from the fact that important decisions were made by the groups themselves. Every effort was made to decentralize progressively as the groups became more familiar and comfortable with the farming systems approach.

Given the interdisciplinary nature of farming systems research and development, and given the very different conceptual frameworks, standard operating procedures, and research designs of diverse disciplines, I think an authoritarian, hierarchical kind of organization is inappropriate and counter-productive. Such an internal team organization is furthermore inconsistent with the philosophy and framework of farming systems R&D itself. Surely if we consider it worthwhile to foster farmer-scientist collaborative decision making, we should similarly think it worthwhile to have participatory decision making within the team.

Reliable coordinating support - The above observation does not, however, obviate the need for coordination. Someone must ultimately take responsibility for ensuring that deadlines and goals that are set by the group are met, in accordance with team decisions. The many details that must be attended to in such joint endeavors must not "fall through cracks," and this should be one of the responsibilities of the coordinator.

Another important component of this role is ensuring that input from all relevant disciplines continues to be incorporated. Although marginalization of input from any discipline has not been a problem in our activities to date, it has certainly been a consistent problem in many development organizations, particularly for the social sciences. Aware of this potential problem, we structured formal meetings such that a variety of disciplines were represented in presentations; and we carefully monitored discussion that no one person or discipline monopolized the time available. In this context, I was a tyrant, heartlessly cutting people off who went beyond our group-imposed time limits on individual comments.

Team Building - Many scientists are unused to working in collaborative team contexts and are hesitant to participate in decision making or in joint endeavours. This was particularly noticeable when we got to the report-writing phase of our activities. One mechanism that seems silly, but I am convinced was powerful, in fostering team responsibility and decision making (as well as removing blame from any one person) was a self-conscious insistence on using the term "we" rather than "I." This was particularly important when it came to written matter. Many of our activities involved the production of letters, memos, reports, agendas, and so on. I would draft such written materials based on group discussions and present them to one group or another for corrections, changes, improvements, and feedback. Particularly with some group members, I found it a continual battle--and one that I consider worth fighting--to remind people that we were producing something, and that if what I had put forth was not what we wanted, we should change it.

A related and final issue that I consider worth mentioning here is the necessity for group members to be willing to forgive each other. As most of us know, interdisciplinary communication is difficult and trying from time to time. And even the most patient of people occasionally reaches the limits of tolerable frustration. Most of us have gotten angry in one meeting or another. But the willingness to apologize and to forgive are essential if a team is to endure and perform its chosen role.

## In Sum

We have completed a Fall Farming Systems Forum, two spring projects and reports (Alvarez, et. al. 1982; Cagauan, et. al. 1982), and are now planning the orientation for teams in two new contexts. HITAHR's farming systems program is proceeding and appears to be gathering momentum as we approach what Dr. Goro Uehara (soil scientist and farming systems planning group member) has called a "critical mass of farming systems enthusiasts in the College."

My own perspective is that, even in the unlikely event that nothing further should happen at HITAHR, our work to date has been worthwhile. We have succeeded in bringing members of disciplines together who normally have no contact; we have made some progress in bridging existing chasms between extension and research, Human Resources and Agriculture, and men and women in the College; we have gained valuable experience in working interdisciplinary; we have broadened our views of farming families and how to work with them; and we have made progress in understanding what kinds of modifications to farming systems R&D are mandated by the Hawaii situation. Well worth the effort!

## REFERENCES


Alvarez, Anne, Carol J. Pierce Colfer, Ramon de la Pena, Jim Holderness, Ted Hori, Harold McArthur, Richard Morse, Betty Jo Thompson, Goro Uehara, and Russell Yost. 1982. Looking at Sugar's Future with Hilo Coast Growers. Report to the Dean, HITAHR, Honolulu, Hawaii.

Cagauan, Bernadino, Carol J. Pierce Colfer, Dana Davidson, Audrey Maretzki, Al Martinez, Ed Mercino, Lori Moore, Perry Philipp, Joe O'Reilly, and Kathy Wilson. 1982. FSR&D Methodology on the Waianae Coast: A Test of Applicability. Report to the Dean, HITAHR, Honolulu, Hawaii.

Gilbert, E. H., D. W. Norman, and F. E. Winch. 1980. Farming Systems Research: A Critical Appraisal. East Lansing: Department of Agricultural Economics, Michigan State University, MSU Rural Development Paper No. 6.

Hildebrand, Peter. 1979. Summary of the Sondeo Methodology, used by ICTA. Proceedings, Conference on Rapid Rural Appraisal. 4-7 December, IDS, University of Sussex, Brighton, United Kingdom. (Reprinted in Shaner, Philipp, and Schmehl 1982: 289-293)

Kolb, David A. 1971. Individual Learning Styles and the Learning Process. Working Paper, Alfred P. Sloan School of Management, MIT, Cambridge, Massachusetts.

Shaner, W. W., P. F. Philipp, and W. R. Schmehl. 1982. Farming Systems Research and Development: Guidelines for Developing Countries. Colorado: Westview Press.

APPENDIX A

FORM B

LEARNING STYLE INVENTORY

Name _____ Years of Education _____

Occupation _____ Major Field of Study _____

Age _____ Sex _____

This inventory is designed to assess your method of learning. As you take the inventory, give a high rank to those words which best characterize the way you learn and a low rank to the words which are least characteristic of your learning style.

You may find it hard to choose the words that best describe your learning style because there are no right or wrong answers. Different characteristics described in the inventory are equally good. The aim of the inventory is to describe how you learn, not to evaluate your learning ability.

Instructions: There are nine sets of four words listed below. Rank order each set of four words assigning a 4 to the word which best characterizes your learning style, a 3 to the word which next best characterizes your learning, a 2 to the next most characteristic word, and a 1 to the word which is least characteristic of you as a learner. Be sure to assign a different rank number to each of the four words in each set. Do not make ties.

| | | | | |
|---|---|---|---|---|
| 1. | _____ discriminating | _____ tentative | _____ involved | _____ practical |
| 2. | _____ receptive | _____ relevant | _____ analytical | _____ impartial |
| 3. | _____ feeling | _____ watching | _____ thinking | _____ doing |
| 4. | _____ accepting | _____ risk-taker | _____ evaluative | _____ aware |
| 5. | _____ intuitive | _____ productive | _____ logical | _____ questioning |
| 6. | _____ abstract | _____ observing | _____ concrete | _____ active |
| 7. | _____ present-oriented | _____ reflecting | _____ future-oriented | _____ pragmatic |
| 8. | _____ experience | _____ observation | _____ conceptualize-tion | _____ experimenta-tion |
| 9. | _____ intense | _____ reserved | _____ rational | _____ responsible |

---

FOR SCORING ONLY

CE _____ 234578 RO _____ 136789 AC _____ 234589 AE _____ 136789

AC-CE _____ AE-RO _____

# APPENDIX B

| | | | | | |
|---|---|---|---|---|---|
| INTROVERTS | ISTJ<br>Serious, quiet, earn success by concentration and thoroughness. Practical, orderly, matter-of fact, logical, realistic and dependable. See to it that everything is well organized. Take responsibility. Make up their own minds as to what should be accomplished and work toward it steadily, regardless of protests or distractions. | ISFJ<br>Quiet, friendly, responsible and conscientious. Work devotedly to meet their obligations and serve their friends and school Thorough, painstaking, accurate. May need time to master technical subjects, as their interests are usually not technical. Patient with detail and routine. Loyal, considerate, concerned with how other people feel. | INFJ<br>Succeed by perseverance, originality and desire to do whatever is needed or wanted. Put their best efforts into their work. Quietly forceful, conscientious, concerned for others. Respected for their firm principles. Likely to be honored and followed for their clear convictions as to how best to serve the common good. | INTJ<br>Usually have original minds and great drive for their own ideas and purposes. In fields that appeal to them, they have a fine power to organize a job and carry it through with or without help. Skeptical, critical, independent, determined, often stubborn. Must learn to yield less important points in order to win the most important. | INTROVERTS |
| | ISTP<br>Cool onlookers—quiet, reserved, observing and analyzing life with detached curiosity and unexpected flashes of original humor. Usually interested in impersonal principles, cause and effect, how and why mechanical things work. Exert themselves no more than they think necessary, because any waste of energy would be inefficient. | ISFP<br>Retiring, quietly friendly, sensitive, kind, modest about their abilities. Shun disagreements, do not force their opinions or values on others. Usually do not care to lead but are often loyal followers. Often relaxed about getting things done, because they enjoy the present moment and do not want to spoil it by undue haste or exertion. | INFP<br>Full of enthusiasms and loyalties, but seldom talk of these until they know you well. Care about learning, ideas, language, and independent projects of their own. Tend to undertake too much, then somehow get it done. Friendly, but often too absorbed in what they are doing to be sociable. Little concerned with possessions or physical surroundings. | INTP<br>Quiet, reserved, brilliant in exams, especially in theoretical or scientific subjects. Logical to the point of hair-splitting. Usually interested mainly in ideas, with little liking for parties or small talk. Tend to have sharply defined interests. Need to choose careers where some strong interest can be used and useful. | |
| EXTRAVERTS | ESTP<br>Matter-of-fact, do not worry or hurry, enjoy whatever comes along. Tend to like mechanical things and sports, with friends on the side. May be a bit blunt or insensitive. Can do math or science when they see the need. Dislike long explanations. Are best with real things that can be worked, handled, taken apart or put together. | ESFP<br>Outgoing, easygoing, accepting, friendly, enjoy everything and make things more fun for others by their enjoyment. Like sports and making things. Know what's going on and join in eagerly. Find remembering facts easier than mastering theories. Are best in situations that need sound common sense and practical ability with people as well as with things. | ENFP<br>Warmly enthusiastic, high-spirited, ingenious, imaginative. Able to do almost anything that interests them. Quick with a solution for any difficulty and ready to help anyone with a problem. Often rely on their ability to improvise instead of preparing in advance. Can usually find compelling reasons for whatever they want. | ENTP<br>Quick, ingenious, good at many things. Stimulating company, alert and outspoken. May argue for fun on either side of a question. Resourceful in solving new and challenging problems, but may neglect routine assignments. Apt to turn to one new interest after another. Skillful in finding logical reasons for what they want. | EXTRAVERTS |
| | ESTJ<br>Practical, realistic, matter-of-fact, with a natural head for business or mechanics. Not interested in subjects they see no use for, but can apply themselves when necessary. Like to organize and run activities. May make good administrators, especially if they remember to consider others' feelings and point of view. | ESFJ<br>Warm-hearted, talkative, popular, conscientious, born co-operators, active committee members. Need harmony and may be good at creating it. Always doing something nice for someone. Work best with encouragement and praise. Little interest in abstract thinking or technical subjects. Main interest is in things that directly and visibly affect people's lives | ENFJ<br>Responsive and responsible. Generally feel real concern for what others think or want, and try to handle things with due regard for other people's feelings. Can present a proposal or lead a group discussion with ease and tact. Sociable, popular, active in school affairs, but put time enough on their studies to do good work. | ENTJ<br>Hearty, frank, able in studies, leaders in activities. Usually good in anything that requires reasoning and intelligent talk, such as public speaking. Are usually well-informed and enjoy adding to their fund of knowledge. May sometimes be more positive and confident than their experience in an area warrants. | |

# IDENTIFYING APPROPRIATE TARGET POPULATIONS[1]

Patricia Garrett

Contemporary farming systems research has applied objectives -- to develop and to disseminate appropriate technologies that increase agricultural productivity and improve the standard of living of smallholders. In order to achieve these objectives, farming systems research must be able to distinguish among groups of smallholders, identify the specific needs of these different groups, and to develop technologies which represent real improvements over existing practices. This is the general problem of identifying target populations.

We have begun to address this problem at Cornell in a farming systems research project which is funded through the Bean/Cowpea Collaborative Research Support Program. Our collaborating institution in Ecuador is the Instituto Nacional de Investigaciones Agropecuarias (INIAP), which is responsible for agricultural research and development programs. One aspect of their overall activities concerns the development of appropriate technologies for the production of basic grains by small-holders. Our role is to cooperate with the smallholder-oriented programs and with the national legume program. Our experience is limited, because field work just began last summer. Nevertheless, we have learned some specific things which have helped us make some preliminary distinctions among target populations in the province where we were working. What I would like to do in this paper, therefore, is illustrate some general principles with Ecuadorian data.

## The Importance of Secondary Data

Research sites can be selected and field work focused if existing secondary data are analyzed before primary data are collected. The quality of secondary data obviously varies from country to country, but whether data are good or bad can only be determined by comparing what published documents report and what one finds in the field. Consequently, although it is fashionable to be prejudiced against secondary data, our experiences suggest that a great deal of valuable information can be found and used.

## Agricultural Census Data

Certainly no farming systems research program should enter the field without the prior analysis of agricultural census data. The detail available to researchers will vary from country to country. In general, the more detailed the data, the better field work can be focused. The task of copying data and calculating percentages is tedious. Nevertheless, we found it invaluable.

Ecuador publishes agricultural census data for the country and for each of the provinces. In the library of the census office, computer printouts by county are also available. Because we were working in one province, we compiled

[1]The research on which this paper is based was supported by AID.DSAN/XII G-0261. The opinions and interpretations are my own and are not necessarily shared by my colleagues at Cornell or at INIAP.

the data for the forty-two counties in that province. We learned a great deal about the organization of agricultural production by farm size category, because the census provided data on many variables, including number of farms, area occupied, crops grown, animals raised, subsistence/market production, family/wage labor employed, mechanization, and tenancy.

These data allowed us to understand the range of variation within the province and to select the counties in which to interview. One table that we used appears on the following page. We selected the first county, Pimampiro, because the commercial production of beans by smallholders was important. The second region, San Francisco de Natabuela, was overwhelmingly small scale, family based, subsistence-oriented agriculture. The next region, Cotacachi, represented the latifundio-minifundio complex. Although small farms were numerous, large farms controlled most of the productive resources. Finally, we selected Otavalo, a populous region which is predominantly indigenous. Little was understood about agricultural production and community organization, so a special Quechua-speaking team worked in this area.

When we worked with agricultural census data, we maintained rather fine distinctions among the small sized farms. Certainly all decision to categorize are somewhat arbitrary, especially because absolute farm sizes does not capture the relative production potential of lands of different quality. Nevertheless, this does allow one to identify the category at which the proportion of farms and the proportion of area become approximately equal. Smallholders in this category are likely to benefit from farming systems research, and the consequences of successful intervention are likely to be more equitable than efforts that benefit producers with more resources. The same data also allow one to identify extremely problematic areas. The proportion of near landless households (defined as having less than one hectare) in Cotacachi is alarmingly high and the resources they control extremely low. These sorts of observations allow one to focus subsequent field work on the more precise identification of groups and regions in which farming systems research has realistic possibilities of success.

Maps

Field research demands good maps -- not only to prevent teams from getting lost but also to correct tendencies to interview only off main roads. The latter is important because random sampling is extremely difficult to achieve under field conditions. To the extent that there is a co-variation of geographic location and social class membership, the systematic use of maps allows a team to capture the range within an area.

In Ecuador, we used three maps, all on a scale of 1:50,000. One was produced by the census department, and it represented an area probability sampling frame that would be used in the future to monitor agricultural production between censuses. We tried it and decided that it did not work for our purposes. We continued to use these maps, however, because they identified large farms by name and the roads were clearly marked.

We relied on soils maps and land use maps, which we obtained from the regional analysis department of the ministry of agriculture. An agronomist with a background in geography, Charles Staver, superimposed and simplified the soils and land use maps. This permitted the demarcation of several major zones and even the identification of large/small, irrigated/rainfed fields. Furthermore, it permitted the Quechua speaking team, led by the anthropologist Paul Dillon,

DISTRIBUTION OF FARMS BY SIZE CATEGORY:
THREE COUNTIES IN IMBABURA
1974*

| Size Category | Percentage of All Farms | Percentage of All Area |
|---|---|---|
| **PIMAMPIRO** | | |
| 0-0.9 H | 20.5% | 1.5% |
| 1.0-1.9 H | 25.1 | 5.0 |
| 2.0-3.9 H | 23.1 | 9.9 |
| 4.0-4.9 H | 22.3 | 22.0 |
| 5.0-9.9 H | 5.4 | 12.0 |
| 10.0-49.9 H | 2.7 | 12.1 |
| 50.0-199.9 H | 0.8 | 11.5 |
| 200+ H | 0.1 | 25.7 |
| **SAN FRANCISCO DE NATABUELA** | | |
| 0-0.9 H | 59.1% | 19.7% |
| 1.0-1.9 H | 20.0 | 20.3 |
| 2.0-3.9 H | 14.4 | 24.7 |
| 4.0-4.9 H | 5.8 | 24.5 |
| 5.0-9.9 H | 0.5 | 4.5 |
| 10.0-49.9 H | - | - |
| 50.0-199.9 H | - | - |
| 200+ H | - | - |
| **COTACACHI** | | |
| 0-0.9 H | 57.2% | 7.5% |
| 1.0-1.9 H | 22.5 | 9.4 |
| 2.0-3.9 H | 13.6 | 11.3 |
| 4.0-4.9 H | 4.2 | 7.2 |
| 5.0-9.9 H | 0.7 | 2.6 |
| 10.0-49.9 H | 0.7 | 6.9 |
| 50.0-199.9 H | 0.6 | 20.9 |
| 200+ H | 0.4 | 34.5 |

* Source: 1974 Agricultural Census, Parochia (County) data.

to use agronomically meaningful variations for selecting communities in Otavalo in which to interview.

The interpretation of soils and land use maps is a skill which I do not pretend to master. One specific use that I see for this information is the identification of particularly fragile environments. Agronomic scientists might find that working in such areas is professionally challenging, but traditional producers are certainly more familiar with the management of delicate ecosystems. I would define such areas as off-limits until farming systems research teams had considerable, successful experience in more advantaged areas. Professionals may be motivated to pursue the challenging or the exotic, but mistakes may accelerate the decomposition of peasant economies in areas where environments are fragile and existence precarious. It is likely that others might disagree with what is essentially an ethical evaluation.

A final, and somewhat parenthetical, comment on the use of maps. We found out about the maps we used in interesting ways. AID/E had assisted in the development of the area probability sampling frame. The Agricultural and Rural Development officer told me about it, but it took four days of persistent effort by our Ecuadorian counterpart, Venus Arevalo, to obtain them. The office which produced the soils and land use maps is located one floor above our collaborating institution. It was a visiting professor from Argentina, however, who told us the name of the person who could make the maps available to us. I mention these specifics not to criticize our collaborating institution but to illustrate a general problem. National institutions may be uninformed about the activities of other departments, and it is frequently easier for foreigners to ask stupid questions and locate elusive material.

Ecuador seemingly employs a small army of cartographers. Other countries do not. The alternative to maps is aerial photographs. Landsat photos exist for all countries, but they are not sufficiently detailed for most farming systems research. Aerial photographs exist for many countries, and Rhoades (1982) explains how they are used at the International Potato Center. These are often available for purchase, usually through the armed forces office which is in charge of maps. In fact, in countries with poorly developed state infrastructure, the local equivalent of the Instituto Geographico Militar is probably the best place to begin a search for good maps to use in field work.

## Types of Smallholders

Farming systems research is sometimes described as a program which can benefit the "poorest of the poor." This interpretation, I believe, is fundamentally wrong. Rather, I would argue that farming systems research can benefit relatively privileged smallholders more than relatively disadvantaged smallholders and that it can benefit landless and near landless workers, in very indirect and marginal ways. Let me outline the argument, beginning with groups most likely to benefit.

## Small Scale Commercial Producers

If one of the objectives of farming systems research is to increase domestic availability of basic foodstuffs, programs directed at small scale commercial producers are most likely to produce positive results in a short time. Furthermore, if farming systems research programs can also reach smallholders who are potentially capable of producing a marketable surplus, this can also improve

the domestic availability of food. In both groups, there are also possibilities of increasing the demand for wage labor, provided the commercial crops are labor intensive. If both agricultural production and employment can be shown to increase, a farming systems research program may win the political support it needs to tackle the problems of more disadvantaged producers.

Smallholders who are already or can easily become commercial producers are privileged in comparison to many of their rural neighbors. Nevertheless, they are clearly not members of the same social class as medium or large landowners. Much of the technology suitable for larger scale production can, however, be adapted to small scale. This technology usually requires cash inputs to contract land preparation, to hire labor, and to purchase commodities like seeds, fertilizers, and pesticides. If the farm is already involved in market production, these cash outlays are not as problematic as they are when cash investments are required for non-market production. Furthermore, agronomists familiar with high input, "modern" farming can recognize what modifications would improve productivity and/or profitability. The problem becomes less an issue of research and more one of extension and marketing.

These points can be illustrated by the study of Pimampiro. Smallholders made intensive use of irrigation, chemicals, and labor to grow high value crops like anise, tomatoes, and beans. The Cornell/INIAP teams determined that pesticide use was much too high because farmers did not know that the same chemicals were being marketed under different brand names. The sole extensionist in the region could not compete with the real extensionists -- vendors of agricultural inputs and the agronomists employed by commercial firms. A competing educational program in this region, run along very traditional lines, would be inexpensive. It would have a high probability of success because these growers were uniformly able to quote prices for all inputs, remember market prices, and calculate profit.

The issue of marketing in this area is more complex. Bean production, for example, was actually for export to Colombia. Very substantial profits were realized by merchants who controlled the frontier and had unsavory reputations. It would be both difficult and dangerous to challenge these merchants. One could consider, however, a cooperative storehouse which used medium to high technology pest control methods to protect growers from market manipulation. This is a very serious issue which has been relatively neglected. There is a very substantial literature on smallholders who produce for international monopolies (e.g. bananas). Smallholders producing for a competitive and highly volatile market, however, may be at even greater risk. A systematic analysis of market organization is essential to farming systems research precisely because agriculture production occurs in a structural context that cannot be understood by focusing on farms alone.

Smallholders Who Are "Peasants"

Smallholders who produce most of their own subsistence and sell modest surplus to buy needed commodities can potentially benefit greatly from farming systems research. Increased agricultural production among peasant strata is likely to improve nutrition and, therefore, rural well-being. It is not likely, however, to increase the market availability of food. For that reason, research to benefit peasants may be vulnerable to political attack.

Peasants may actually be difficult to find in some countries. Throughout Latin America, for example, there has been a profound differentiation of the

peasantry. Some smallholders have accumulated capital, increased production, and entered a process of expanded production. Others have moved in the opposite direction and are experiencing a process of disaccumulation which is sometimes called depeasantization or proletarianization. When differentiation reaches an advanced stage, real peasants may be hard to find.

In the Ecuador field work, for example, we made real efforts to find peasants. Of the hundreds of people we interviewed, we found only a handful. Uniformly, they had lands distributed in more than one zone (vertically), produced a wide variety of crops, and had complex relationships between crop and animal enterprises. Uniformly, they were linked to the market, selling modest surpluses and buying commodities for consumption. A classical subsistence producer with no market relationships we never found. Furthermore, we are confident that they do not exist in that province.

A farming systems orientation is the only viable approach to developing appropriate technology for peasants. Nevertheless, it must be recognized that this is very demanding in professional skills. The peasant enterprises we examined were extremely complex in comparison to small scale commercial farms. They included crops which had never been serious objects of agronomic research, and the complexity of intercropping was remarkable. The division of labor between men and women, adults and children was fundamental to the organization of agricultural production, as was involvement in the community, especially through kin networks. Rituals and holidays, including the need for a specific food to celebrate important saints' days, was an important determinant of the agricultural calendar. The need for a multidisciplinary approach and a multifaceted analysis is eminently clear.

Near Landless Households

Farming systems research can do little to benefit near landless households. This is especially true if they are concentrated in ecologically marginal regions which have experienced the accelerated decomposition of peasant economies. These regions still merit study to understand the process of proletarianization. Nevertheless, the possibilities for positive interventions that will make more than marginal improvements are objectively limited.

In the interview guide we designed at Cornell, we included questions about how agricultural production had changed in regions over the last twenty-five years. This allowed informants to discuss long-term changes in land use patterns, irrigation systems, rotation practices, the availability of lands for pasture and fuel wood, resettlement patterns, and land subdivision. These commentaries, combined with observation in the field, gave us an initial sense of how intense and rapid was the process of environmental degradation in certain areas. We had to recognize that in at least one sub region the problems were beyond the ability of our collaborating institution to address.

There are some households with resource bases so inadequate that solutions to their problems of poverty cannot be resolved by increasing on-farm production. Few governments care to acknowledge this fact in a straightforward manner because it simply raises questions about the inequitable distribution of land and other productive resources. The current Chilean government has candidly stated that agrarian reform is complete and that approximately 25% of the agriculturally active population has problems which cannot be addressed by agricultural development. This sector requires the development of other income generating activities.

This rather cold-blooded analysis reflects reality. Income from wage labor may be extremely important among small holders, especially for households which are near landless. The implicit assumption of farming systems research, however, is that on-farm production is the exclusive or most important source of peasant income. In cases where this is true, increased on-farm production will have a relatively large impact on income (in cash or in kind). If household income derives largely from wage labor, however, higher wages earned in agricultural or non-agricultural work would have the greater overall benefit for households. Whether one calls this strata near landless or semi-proletarian is less important than the ways in which their needs are different from and similar to other landed households.

Migration, short-term but especially long-term, places severe burdens on semi-proletarian households. In Latin America this is mostly male migration, but in the very poorest households women may migrate also. A male migrant may return home only to find heavy agricultural tasks awaiting him. Alternatively, his wife and children may have taken on tasks that he would have otherwise performed. A female migrant would find it extremely difficult to maintain animals, and the dissolution of the animal enterprises may destroy the only safety net the family has under its own, rather than kin, control. Finally, the need of one or more persons to migrate seems to increase the risk that necessary maintenance of the farm infrastructure -- fences, canals, tools, etc. -- will be postponed. One hypothesis is that the failure to maintain infrastructure is the most critical factor in accelerating the decomposition of semi-proletarian households (Chaney and Lewis, 1980).

Very limited land bases make programs oriented towards crop improvement extremely problematic. The difficulties are only compounded by migration. Double cropping may be viable in some areas, especially if it allows people to withdraw from wage labor or return home in time to tend the second crop. Double cropping may not be viable in other areas if migrants are unable or unwilling to return. Whether a technologically feasible alternative is viable varies, in part, according to the availability of labor. This is why it is critical to collect data on seasonal labor demands, with special attention to peaks and troughs and relate that to the seasonal availability of food. A small stand of early maturing maize (like INIAP 101) that can be eaten on the cob when little else is mature can make a substantial difference at an otherwise hungry time. Appropriate technology may fill small but important niches without displacing local varieties.

Systematic attention to small animals may open new possibilities. While we were doing field work in Ecuador, we were struck by the importance of guinea pigs. We found them even in the homes of landless workers who lived in villages. We also found them in areas where no other animals were kept because of chronic problems with theft. This can happen because guinea pigs are kept in the house, safe from the perils of street traffic and robbers. Furthermore, the grasses they eat can be foraged with considerable ease, even by young children.

One of the Ecuadorian technicians with several years experience in this zone has developed with me a proposal to fund a pilot program. It involves the loan of larger Peruvian guinea pigs; the construction of simple pens from locally available materials; and the initiation of simple alfalfa trials to determine which of numerous available varieties will do best under on-farm conditions. Most of these guinea pigs (but hopefully not the pure bred starters) will be consumed by the family. There is also a market for surplus, and the

price of one guinea pig was approximately equal to a day's pay for male agricultural labor. The proceeds of such a sale would go to the female owner and, therefore, into the budget which is spent principally on household maintenance (food, school fees, medical expenses, etc.).

This proposal has several features which make one believe it is appropriate even for semi-proletarian households. It requires no cash outlay; it is consistent with the traditional division of labor; it potentially allows for both subsistence and market production. Whether we can get it funded and whether it actually works remain to be seen.

Some Thoughts on Multidisciplinary Teams

I believe it will take time for agricultural research institutions, which are just moving off experiment stations, to develop the skills necessary to be effective with peasant and semi-proletarian house-holds. Some interviewing may increase sensitivity and raise questions that eventually suggest experiments. There is surely an important place for pre-intervention farming systems research which identifies researchable problems that can be pursued initially on experiment stations.

On-farm research, however, should build on institutional strengths, remain basically in line with technology which is ready to go on in the pipeline, and develop the capacity for innovative problem formulation and problem solving with smallholders. Putting it more strongly, farming systems research should not be used as a justification to go slumming with peasant and semi-proletarian households, and to muck around with systems whose complexity is only dimly grasped. Technicians must become acutely aware that the existence of many households is precarious and that mistakes can accelerate their decomposition.

In working with peasants and semi-proletarians, I believe there are several specific recommendations one might make. Agronomic scientists, in my experience, think of plant breeding first when they consider how to improve cropping systems. I believe this tendency must be tempered somewhat in countries like Ecuador which have very pronounced ecological variations. In a single community in Otavalo, informants reported twelve varieties of maize and six varieties of beans, one of which (called misturiado) is actually a mixture of beans of different colors and growth patterns. It seems likely that a single improved variety could supplement, but not replace completely, existing local varieties. Other modifications of cropping systems might improve the productivity of local varieties. ICTA in Guatemala has substantial experience in redesigning and fine tuning traditional systems, but many other institutions are new to it.

Animal scientists need to be incorporated into farming systems teams, especially if the group to be assisted is peasant and semi-proletarian producers. McDowell and Hildebrand's monograph (1981) suggests animals may be critical components in the overall organization of farming systems. This is not only the interpretation of professionals. Especially in the region of San Francisco de Natabuela, which is eminently small scale, subsistence oriented production, informants spoke consciously and deliberately about the integration of cropping and animal enterprises. This integration required the complementary activities of women and men, adults and children. Its understanding required that both men and women be interviewed because they were better able to report on different activities.

We did not have an animal scientist involved in either the development of the interview guides or the conduct of field work. Our research suffered as a consequence. Nevertheless, we learned some specific things which might be relevant to others working with peasants. The ownership of animals can be very complex, even inside a single household. Specific animals may be "his," "hers," or "ours," and only in the case of "ours" are decisions taken by mutual agreement. This phenomenon is often called "separate male and female budgets," and it may exist in crop or animal enterprises. Who actually controls the enterprise is the person with whom the farming system researcher must deal. The issue of control is complicated when animals are given and received in "shares." We found several examples of large animals which were pastured in another's field. The critical issue in such share arrangements was who controlled the manure. Tenancy has long been recognized as a central issue with regard to land; the Ecuadorian material suggests that it is also critical to understanding animal enterprises.

Sociologists and anthropologists usually have special responsibilities for considering the organization of the household and its integration into the community. I believe it is advantageous if at least one is female. In peasant households, the process of agricultural production and consumption is a cycle in which women play critical roles. These roles can be overlooked if questioning stops at harvest. Primary food processing, storage, and seed selection are productive tasks, which are related to, but distinguishable from, household maintenance per se.

It may be possible to intervene in processing, storage, and/or seed selection, thereby improving food availability without modifying farming practices at all. One specific example may illustrate the point. In some regions in which we interviewed, seed selection was done very carefully by women. Skill was highly valued and taught mother to daughter. The criteria used related to the appearance of the crop kept for seed. Imagine that, in addition to these criteria, agronomists would help these women recognize and tag growing plants which exhibited resistance to prevalent diseases or pests. Women could then learn a new skill, complementary to existing skills, which could improve seed selection and hence agricultural production. This kind of intervention possibility is likely to be overlooked if agricultural production and consumption are not treated as a cycle.

Agricultural economists pose special problems of integration into teams focusing on peasants. If they are trained in classical microeconomics, they have been taught to monetize all inputs into a production process, whether or not a cash transfer occurs. This training is an asset for working with small scale commercial producers, but it is an absolute liability for understanding why peasants organize production as they do. Peasants do not depreciate the hoe which was a gift from a friend; they do not pay family members or themselves "imputed" wages. They do calculate whether exchanges of goods of labor are reciprocal; they do plan production to coincide with important events (Shaning, 1974). Their decisions may be economically irrational, but they may be eminently reasonable from other perspectives. As the "new home economics" has amply demonstrated, even exotic activities can be forced into traditional micro-economic models. They may win their authors some notoriety, but they will not shed any light on why peasants believe they do what they do. The traditional orientation of production economists poses no problems in dealing with small scale commercial producers. Here the analyses of agricultural economists

and agronomists are eminently complementary. In peasant and semi-proletarian households, however, the training of sociologists and anthropologists makes it easier for them to understand peasant criteria for decision making.

It is extremely important to understand criteria even if professionals also reinterpret these criteria and express them in terms relevant to their own disciplines. Consider the controversy surrounding plant breeding criteria like how increased yield should be calculated -- yield per hectare, yield per plant, or yield per unit of seed planted. If smallholders report that they calculate yield per unit of seed planted, breeders can include that criterion along with other discipline-relevant criteria in breeding programs. This is one specific way that farming systems research can assist the development of technology which will be regarded as appropriate by smallholders.

# BIBLIOGRAPHY

Chaney, Elsa M. and Martha W. Lewis. 1980. "Women, Migration and the Decline of Smallholder Agriculture." AID/otr-147-80-94. October.

McDowell, R. E. and P. E. Hildebrand. 1980. "Integrated Crop and Animal Production: Making the Most of Resources Available to Small Farms in Developing Countries." Working Papers. The Rockefeller Foundation. New York. January.

Rhoades, Robert E. 1982. "The Art of the Informal Agricultural Survey." Training Document 1982-2. Social Science Department, International Potato Center, Lima, Peru. March.

Shanin, Teodor. 1974. "The Nature and Logic of the Peasant Economy." Journal of Peasant Studies 1:64-80.

# GOAL CONFLICT AND INCENTIVES AMONG INSTITUTIONAL PARTICIPANTS

Nancy W. Axinn

Report of small group discussion at the Farming Systems Research Symposium, KSU, November 23, 1982.

Most of those attending these discussion sessions had first hand experience working as a member of a farming systems (or related type research) research team. In the course of the discussion, the following points were made.

## Goals

A number of parties to goal conflicts were identified, including those:

1. Within teams.
   a) between team members
   b) teams goals vs. individual goals

2. Between individuals and sponsoring institutions (i.e., departments and colleges).

3. Between U.S. team and national team in country of assignment.
   a) on an individual level
   b) on the team level

4. Between teams and national (host country) institutions.

5. Between groups committed programatically and donor agency.

6. Within one scientist, as the difficulty of establishing professional identity in FSR competes with other opportunities.

## Incentives

Some incentives for getting involved were identified. Some of these are institutional incentives, rather than personal. It was acknowledged that these incentives may also be a conflict in goals. They include:

1. A pre-retirement reward (no longer effective in U.S., but may make contribution elsewhere).

2. Escape from an uncomfortable situation (personal or professional) in the U.S.

3. In a rut in present job.

4. Opportunity for travel.

5. Economically profitable.

6. Missionary spirit.

There was some feeling that none of the above were really appropriate incentives, although they have been motivating factors in the past.

Personal incentives which could strengthen farming systems research participation include:

1. Opportunity to learn about innovations used elsewhere which can be applied in the U.S.

2. Acquisition of field experience to enhance teaching.

3. Opportunity for creative inputs into developing interdisciplinary methodology.

4. Opportunity to work closely with people from other disciplines (impact on other disciplines).

5. Opportunity to work on practical, real, important problems of an applied nature.

6. Opportunity to develop professional (and personal) linkages with institutions in other areas of the world.

7. Opportunity to gain an appreciation of the capabilities of professionals of other nationalities through interaction.

8. Opportunity to expand understanding of theoretical knowledge.

9. Opportunity to reexamine beliefs, understanding and paradigms under new conditions.

Resolution of Conflict

Resolution of goal conflict was briefly discussed, especially related to conflicts among U.S. team members. These conflicts may prevent achievement of team goals.

1. Team building exercises were recommended by those who had been members of teams which used them and those who had been members of teams which had not used them. It was agreed that an in-depth orientation was very important. It was suggested that the team emphasis undercuts self confidence, especially for new members. Each team needs to reach a consensus of what Farming Systems Research is (before going into the field).

2. Membership on teams was discussed. It was suggested that the following are important characteristics for team members:

    a. Willingness to listen to people from other disciplines.

    b. Secure in their own field.

    c. Willing to learn, take training, work in the field.

    d. Willing to share ideas, discuss, etc.

One experienced team leader stated that it is important to get the right person (with above A-D characteristics) rather than a representative of any particular academic field, and it was important to include at least one woman on each team.

Rewards

Much of the discussion centered on the consensus of the group that U.S. universities are not presently structured in a way which can reward participants in farming systems research. These concerns included:

1. Tenure. Professional evaluation and advancement are in conflict with institutional requirements. These decisions are made in departments while FSR is across departments. Theoretical, academic versus applied and service concerns are also a factor. The consensus was that most of the universities don't reward farming systems research team members with tenure and promotion. This is a serious concern, as it reduces the involvement of young professionals who are sincerely interested in FSR.

2. Promotion. It was suggested that criteria for evaluation of overseas personnel for university promotion are lacking. One person suggested infusing FSR with outside blood from liberal arts, not land-grant schools. Department boundary maintenance vs. farming system research was discussed.

3. Publications. Opportunities for publication are important for A and B above. Publication opportunities for FSR are very limited among the "juried" journals of disciplines.

University Support for FSR

Several universities with policies which seemed to support FSR were identified. In one, the department heads of the farming system researchers are a policy committee which commits them to support of those scientists. And, these same departments have a technical advising committee of scientists to give support to the field.

Future symposium programs might deal with any/all aspects discussed.

# LINKING SCIENTIST AND FARMER: RE-THINKING EXTENSION'S ROLE

J. Lin Compton
Cornell University

The small landholder, limited resources farmer will be around for as long as it is necessary for the rural sector in the developing countries to provide the primary employment base for people. Increasing agricultural production through large scale, mechanized, and commercial farms can be disruptive of the larger national economy and polity by creating extensive rural out-migration of displaced farm people to already over-crowded and burdened urban centers. Consequently, it is imperative that concern for increasing agricultural production be in balance with attention to the general welfare and quality of life of rural people.

In this context, Extension Services face a major task of assisting the world's multitude of small landholders to identify, adopt, and adapt technology appropriate to location-specific soil, water, climate, labor, and economic conditions in order to make the small farm a viable economic unit. These economic and political concerns combined with the general dynamics and persistence of the food and population crisis call for a greater scope, intensity, and quality of effort by Extension programs if farmers are to receive relevant and realistic assistance and advice on a first-hand and timely basis.

From this general background emerges the rationale for the major theme of this paper: the use of a systems perspective in the analysis, design, and operation of Agricultural Extension programs in order to assure coherence and efficiency of effort and relevance and effectiveness of result. Various aspects of Extension have been studied and reported in great detail by others. The emphasis here will be on questions and issues concerning the inter-relatedness of these units and dimensions of the overall system. Matters concerning agricultural research will be dealt with only as necessary to complete the paradigm, since research is treated in greater detail in several related papers.

## A Systems Perspective

It is now generally accepted that the conceptualization of Extension as a service for communicating the results of scientific research to farmers neglects the importance of the problem-solving processes of education and social organization in agricultural and rural community development. As a result of this realization, increasing attention is being given to three related questions: "What is appropriate technology?" "How and by whom should appropriate technology for small farmers be determined?" "How can farmers be best helped to learn about and properly employ this technology?" The following nine-cell "systems" matrix illustrates a set of relationships which will be discussed at greater length in pursuit of answers to these questions.

| | R | E | F |
|---|---|---|---|
| Research | A<br>IOKS | B<br>Feed-in | C<br>FSR[2] |
| Extension | D<br>Feed-back | E<br>Extension | F<br>Feed-down |
| Farmer | G<br>FSR[1] | H<br>Feed-up | I<br>IKS |

In the above, IOKS refers to the Institutionally Organized Knowledge system which is based on scientist-derived knowledge. IKS refers to the Indigenous Knowledge (or farmer-derived knowledge) System and recognizes the gradual awareness by agricultural scientists, administrators, and educators that such a knowledge system does exist. FSR refers to farming systems research wherein an effort is made by multi-disciplinary teams of social scientists (e.g. anthropologists, sociologists, extension educators, nutritionists, communications media specialists, and economists) and technical agricultural scientists (e.g. plant pathologists, plant breeders, soil scientists, crop scientists, and entomologists), along with farmers to identify and study "human - crop - animal - society - climate - soil - water" interactions that influence behavior and production. FSR refers to an assessment of the reflection of existing farming practices in what scientists recommend. $FSR^2$ refers to an assessment of the extent to which scientists' recommendations are reflected in what farmers do. The answers to these two obverse questions have very different implications. Feed-in, feed-down, feed-up, and feed-back designate key points of interaction among scientists, Extension staff, and farmers. As the title of this paper suggests, Extension is juxtaposed between research and farmers as a linking force.

Structural Units and Functional Linkages

An analysis of agricultural systems in general would encompass scientific agriculture, indigenous knowledge, farming systems research, and extension education and their relationships to each other. These relationships could be studied by pursuing an answer to the question of "who does what for whom, why, how, how well, and with what result?" The following discussion centers on this question. The traditional top-down pattern (see boxes A, B, E, F, and I) will be discussed, followed by a description of an atypical bottom-up pattern (Boxes I, H, E, D, and A) and a discussion of the role of farming systems research in this new paradigm.

Agricultural Research (Box A)

An analysis of the institutionally organized knowledge system (IOKS) itself would encompass the nature and extent of the interactions among the international agricultural research centers, national agricultural research centers, and such in-country, regionally-based resource institutions as universities, agricultural colleges, and agricultural experiment stations (Moseman). From an extension education viewpoint, a major concern is the extent to which two-way knowledge flows have been institutionalized within the IOKS sector so that discoveries reflect the results of research on relevant problems and are communicated quickly and fully to all interested scientists, Extension personnel, and farmers. A Michigan State study suggests personal relationships among scientists stationed at various international centers are more of a determining factor in the establishment and maintenance of interactions and informal resource-sharing networks than is common interest in the research problems on which these scientists focus. A major set of questions, then, concerns the extent to which international center scientists actively solicit information or suggestions from country scientists, the extent to which they attempt to maintain contact with and encourage the work of country scientists, and the extent and value of more formal networks among scientists at all levels working on similar problems.

From a national agricultural research perspective, other questions important to farming and Extension operations arise. Since the predominant pattern

is for Research to be a centrally controlled program with major decisions on priorities, budgets, staffing, and the geographic location of activities being made at the national level (Ruttan, p. 110), there is a need to be concerned about the selection of research problems and their short and long-range relevancy to local problems. Farmers and extension staff should be incorporated into the process of helping to determine research priorities, especially since Extension is basically a de-centralized provincial or state level affair and is therefore, along with farmers, more aware of location-specific realities. Under present arrangements in most countries, they are seldom involved in such research decision-making; this results in unnecessary social and communicative distance among scientists, educators, and farmers and poor understanding of the nature, purpose, and value of the research results by the latter two.

Research and Extension Linkages (Box B)

Various factors have a negative effect on the transmission of information between Extension and Research. Extension workers frequently see researchers as being shut up in their laboratories, giving little attention to social and economic factors, using obtuse language, having no commitment to the formation of firm opinions about their research results, and carrying out research without any application in mind.

Research scientists, on the other hand, see extension workers as being unwilling to trust or accept research findings, as being unwilling to ask research scientists for information when it is needed, as not helping to clarify the nature and extent of field problems which need researching, and as demanding immediate answers to urgent problems which, in fact, call for longer periods of time to work out solutions (Arnon; Elkana).

Some countries have tried to reduce these tensions by housing Research and Extension within one institution (see Nagel's study of India's Agricultural Universities) or administratively forcing integration of the functions (see Steinberg, et. al. report on Korea's ORD) in a very authoritarian but effective way, or by coordinating these different models through an overall council approach (Ruttan, p. 107). Regardless of which approach is deemed most appropriate for any particular country's socio-cultural and political-economic conditions, the major questions remain how to interrelate 1) theory with practice, 2) basic research with applied or adaptive research, 3) the work of scientist with educator, and 4) concern for production with concern for equity.

Extension Programming (Box E )

Extension is charged with the task of science simplification and transmission, of re-working research reports and preparing ways and means of presenting information to farmers. Such characteristics of innovations as soundness, rationality, complexity, divisibility (the extent to which an innovation may be tried on a limited basis, a little at a time or part by part), compatibility, relative advantage, and communicability (Havelock, p. 8-38-8-45) should be taken into account. Strategies for message delivery should be chosen on the basis of considerations of available media, personnel, urgency, distance, and farmers' familiarity with different media and their preparedness to receive certain types or levels of information. In short, Extension must help bridge the social, cognitive, and geographic distance between a small group of scientists and a large farming community by selecting or designing methods most appropriate for particular message content and the farmers' state of readiness.

Subject matter specialists (SMS) and training staff play critical roles in simplifying science and training extension field staff or farmer-leaders. Most countries are still struggling to generate a sufficient number of highly competent SMS's and trainers to staff field stations and provide a high quality and intensity of input into the extension education process. Knowledge of training strategies and methods, for both clientele and staff development purposes, has grown immensely in the past ten years (for example, see Lynton and Pareek; Havelock, 1972), but the number of those trained to implement this knowledge falls far short of the demand. University and college programs are growing, quantitatively and qualitatively, to meet this challenge and during the next ten years considerable progress can be expected.

A major set of issues in extension programming revolves around decisions of whether to emphasize the training of selected farmers as educators of other farmers or to expand the number of village-level extension agents and place them on a rigid and intense schedule of visits to farmers, followed up by training seminars for these agents as provided by SMS's and training staff (Colle). The two separate models implied (Benor; Compton, 1973) are based on very different assumptions and beliefs, discussion of which would go beyond the immediate focus of this paper on the overall system of Extension and the interrelatedness of its various structural units. Research and evaluation studies now being conducted by objective scholars should help resolve these issues within the next few years.

A related issue is the selection of training strategies; there are two major alternatives: village-based training of farmers by extension staff, or the use of residential training centers to prepare farmer-leaders (Mamat). Considerations of cost-effectiveness in relation to what many developing nations can afford are likely to remain important for some time to come. Farmers Training Centers with a strong interdisciplinary staff, complemented by a mobile staff for making follow-up field visits, can make a larger impact over a vast area than scattered and isolated field staff operating alone. Training can be given economically and, in many cases, can be enhanced by receiving psychological and financial support from locally-organized farmers groups. Such centers also provide a forum for generating new ideas and obtaining training inputs from agricultural colleges, universities, or research station scientists. This strategy can facilitate an articulation of evaluation, planning, and training processes, especially if participatory approaches are used which involve combined groups of farmers, field agents, SMS's, trainers, administrators, and researchers sitting down collectively to analyze how well the system of services is operating and identifying ways and means for improvement. This strategy also makes it possible to shift the focus of effort from one area or group of villages to another as changing needs and priorities dictate (Compton, 1977).

Extension - Farmer Interface (Box F)

Analyses of the impact of the Green Revolution on farm production and rural welfare have revealed that positive results, however great, have been less than expected for two major reasons: the technology packages were ill-suited to the resource constraints faced by the poorer farmers, and strategies to diffuse the new technology tended to rely upon the more progressive farmers as models for emulation by the others. This "first the best" era has led us into a "now the rest" era with its strategies emphasizing local social organization and interest-learning groups as means of assuring that the needs of the poorer farmers will be addressed.

There are at least three major focal points regarding farmer-Extension interface: 1) the proper functional role and behavioral style of the field agent, 2) the more specific mode and pattern of agent interaction with individual farmers and farmers' groups, and 3) the proper balance and use of a variety of communication and teaching techniques so as to support and reinforce learning rather than control or direct it. The typical field agent today in the developing countries is young and often lacks significant personal experience in farming. The typical agent may also have been the recipient of inappropriate or insufficient academic training to prepare him/her for effective interaction with older and practically experienced farmers. The opportunities for learning on the job should be great, however, as the number of technical specialists and competent training staff increases, and staff development/field agent training becomes an integral part of a coherent systems operation.

The behavioral style of the field agent represents a topic of considerable discussion. Cultural broker, gatekeeper, activator, multi-purpose worker, and many more terms have been used to describe the agent's role. One conceptualization suggests that in order for an agent to be allowed by farmers to serve as a mediator[1], an agent must first be seen and accepted as a facilitator[2] (Compton, 1972). The characteristics and skills of facilitator have been studied extensively (Etling). Extension training staff may need to give as much attention to helping field agents acquire or develop these skills as they presently give to agents' technical training.

In addition to behavioral style, there are concerns about the agent's choice of farmers with whom s/he will interact. If such decisions are left entirely to the agent's discretion, more bad than good may well result. Instead, there needs to be greater emphasis on the role of local farmer associations, when these exist, in determining the nature and frequency of interaction with the agent. Earlier U.S. experience with local Farm Bureaus (which employed the extension agent and held him accountable for providing current and useful information to the farmers), combined with what we have learned about the effectiveness of Taiwan's farmer associations in assuring agent accountability, would suggest that farmers' collective voices in such matters are of critical importance. When such associations do not exist, an alternative might be the formation of farmer learning groups based on common interests. The groups themselves would select various members for specific kinds of interaction with extension agents or trainers. The key principle here is to somehow guarantee that some farmers will not be excluded from the educational process because of low socio-economic status.

Farmers typically differentiate and acknowledge which ones among them are particularly skillful or successful with specific crops, animals, or farming practices. This fact should be capitalized upon by Extension, not for the purpose of helping the successful simply to become more successful, but in order to mobilize and utilize such indigenous talent to benefit the group or community as a whole (Compton, 1973; Compton, 1979). This strategy has been

---

[1]One who encodes messages from one source and then decodes or translates them so that they can be understood by a target audience, usually in a two-way formulation.

[2]One who has the best interests of the clientele in mind, and who possesses interpersonal skills basic to encouraging clients toward self-improvement.

successfully employed and in such a way that various interest-learning group members are selected by their peers to receive training related to some specific aspect of the group's topic. For instance, a member of a group on field crops is selected to receive training in seed selection, while another member receives training in insect control, and another in disease control. To reap the ultimate benefit of each other's learning, they are compelled by necessity and peer pressure to share what they learned through their separate training sessions (Compton, 1977).

The role of communications media in such a scheme as the one just described must become a supporting role, not one aimed at initiating or catalyzing farmers' thinking. Why? The answer involves factors of power and manipulation on the one hand and sound learning theory and practice on the other. It is now generally accepted that for learning and behavioral change to take place effectively and in directions conducive to the common good, adult learners must plan an active role in defining the nature of their own reality and in determining the steps they should take to deal with it. This internalization process results in the motivations which are so necessary to sustain human action upon a "problem" or need. This process is best promoted through dialogue. Unfortunately, most extension work in the past and even today tends to employ communication approaches which inhibit dialogue and critical thinking.

Sociologists have pointed out the critical role played by those persons who occupy positions in which decisions are made about what information is to be transmitted to whom, when, and in what manner. Power to manipulate and control the flow of information is power to control the development of knowledge itself. Communication strategies and methods need to be used which promote dialogue and which can be used to provide positive responsive support to decisions reached through dialogue. Extension as an educational process must have two-way communication or dialogue as its central thesis (see Freire's treatise "Extension vs. Communication" -- an unfortunately misleading title because it suggests that Extension personnel do not allow dialogue or two-way communication to take place when, in fact, those who see themselves as Extension "educators" do this, and information specialists do not. Fortunately, the message contained in the text itself exonerates extension educators who do not fall into the semantic trap of simply extending information).

One underutilized communication strategy in extension work is the use of folk media to promote awareness and stimulate interest in development topics, themes or issues. Such media can be and have been used successfully for this purpose and, in turn, have been themselves strengthened (Compton, 1980). Drama, debate, poetry, and lyrics embellished with music and dance attract and hold attention while also providing an opportunity for local participation in preparing and presenting an entertaining and educational experience.

Indigenous Knowledge Systems (Box I)

Decisions to adopt or reject a new agricultural innovation are strongly influenced by, among other things, the knowledge, skills, values, and belief systems of farmers. Farmers typically step back away from interactive situations with "outsider" change agents, and dialogue among themselves before adopting or rejecting an innovation. Such farmers have communication networks among themselves which are based on interpersonal relationships and which become relatively stable and predictive of behavior (Rogers, 1981). The fact that farmers have an indigenous knowledge system and communicative structures through

which it is tested, developed, and spread suggests that extension workers might do well to learn about, from, and through such systems and structures, both for the inherent value in such knowledge itself and because mutual-awareness of it by agent and farmer can promote meaningful dialogue.

Along with the emerging awareness and appreciation of the existence of indigenous knowledge systems have come questions of what can be learned from the farmer, how, and how this can be used in agricultural development programs (Brokensha, et. al., 1980). An increasing number of studies have documented farmer knowledge of such ecological and environmental factors as microclimate conditions, rainfall patterns, water levels, water retention capabilities of soils, what plants will grow in which type of soil, and soil responsiveness to fertilizers and manure. Farmer classification systems for soils and plants have been found to be comprehensive, logical, and useful. Farmer knowledge of such matters as mixed cropping patterns, the best times to plant, and ways of controlling or eliminating plant and animal diseases has been incorporated by scientists into their own work. It has even been suggested that both farmers and scientists be seen as professionals and encouraged to learn from each other (Chambers, 1980).

Learning from the Farmer (Box H)

Extension field staff, numerous, widespread across the countryside, and in daily contact with farmers are in an ideal position to monitor and access indigenous knowledge. Unfortunately, few agents receive training which would prepare them with the proper set of skills and attitudes for learning from the farmers. Warren (1979, p. 117) has stated the challenge well:

> A humanistically-oriented applied anthropology must be based on a knowledge of indigenous epistemological systems and social organization, a conscious effort to define problems from the indigenous viewpoint and hence the establishment of local involvement in change programs from their onset. It must also be concerned both with the ethics and values of the local population and with those upon which the external change agent operates in attempting to design a program of implemented change. This approach involves the role of the change agent as a communications facilitator between local populations and national and international agencies and provides the local population with an opportunity to increase the available options for change, thus enhancing its freedom of choice.

Extension agents should be taught the skills of active listening and observation, how to conduct guided interviews, to keep journals and diaries, how to make use of games, pictures, contrived devices for stimulating exchange and eliciting information and perspective from farmers, and the tactic of engaging in joint agronomic ventures with farmers in order to learn on the job.

Accumulating, Processing, Articulating Farmer Knowledge (Box E)

Ideally, extension field staff reports of farmer innovations and knowledge would be followed up by a Subject Matter Specialist for IKS. Such as SMS, specializing in the methodology of eliciting IKS and charged with responsibility for cataloging and storing it and preparing it for communication to relevant research scientists, would be stationed within each province, state, or training center. This accumulated, documented knowledge could also be made

use of during training seminars. Scientists, trainers, SMS's, and field agents could learn from this store of farmer knowledge, and farmers could learn from the experience of other farmers living on the other side of a province.

Sharing IKS with Scientists (Box D)

In the conceptualization of a bottom-up pattern described thus far, new and projected interactions are being suggested. The suggestion that scientists can and should be helped by extension personnel to learn and appreciate farmer knowledge may sound strange and foreign. And yet the reality of scientist/extension staff ratios dictates that scientists be made aware of knowledge and insights gained by extension personnel through their daily contact with farmers, a luxury which any country's handful of scientists does not have. Existing status differentials and bureaucratic separation of scientists and extension workers, however, serve to block significant interaction of the type and for the purpose being depicted. This, in effect, represents a major programming hurdle to be overcome in the years ahead.

Re-thinking Research Priorities Box A)

Scientist awareness of IKS and their understanding of traditional practices of farmers should be seen as a prerequisite to decision-making regarding the priorities of research to be conducted by the scientists. The knowledge gains to be made and the human relationships to be strengthened by dialoging with experienced extension field staff and SMS's about IKS far outweighed the effort that might initially have to be expended to establish such dialogue.

A Mutual Learning Transaction (Boxes C and G)

Scientists need to spend a certain amount of time in direct interaction with farmers and farming systems situations. Because of the complex, multifaceted nature of many farming situations, there is a need for teams of scientists representing different disciplines to cooperatively study, analyze, and reach conclusions about ways of helping small farmers better cope with the existing constraints to production (Gilbert, et. al.; Harwood). Obviously, farmers and selected extension staff should be part of such teams, farmers because of their potential for contributing to the team's understanding of a problem and Extension because of the desire to assure a speedy and effective dissemination and utilization of resulting knowledge gains to benefit other farmers.

As a summary to the broad outline that has been sketched thus far in this paper, we can expand the initial nine-cell matrix to encompass the important aspects of the preceding detailed discussion.

Discussion Questions

1. Who are better teachers of farmers: extension agents or other farmers?

2. What is an indigenous knowledge system (IKS)? What are the sources of IKS? Of what value is outsider awareness of indigenous knowledge in the design of development projects and educational programs? How can IKS best be studied, processed, and utilized to promote development?

3. What are the advantages and disadvantages of residential training centers and village-based training schemes?

4. How can existing gaps between Research and Extension be bridged?

5. How would you respond to a statement that "Extension has nothing to extend?" Does this question reflect the true nature and purpose of Extension Education's role in development?

BIBLIOGRAPHY

Arnon, Isaac. Organization and Administration of Agricultural Research. New York: Elsevier Publishing Company, 1968.

Bass, Bernard M. Stogdill's Handbook of Leadership: A Survey of Theory and Research. New York: Free Press, 1981.

Benor, Daniel and James Q. Harrison. Agricultural Extension: The Training and Visit System. Washington, D.C.: World Bank, 1977.

Brokensha, David W., D. M. Warren and Oswald Werner (Editors). Indigenous Knowledge Systems and Development. Lanham, Maryland: University Press of America, 1980.

Cernea, Michael and Benjamin J. Tepping. A System for Monitoring and Evaluating Agricultural Extension Projects. Washington, D.C.: World Bank Staff Working Paper No. 272, 1977.

Chambers, Robert. "Understanding Professionals: Small Farmers and Scientists." New York: International Agricultural Development Service, Occasional Paper, 1980.

Colle, Royal D. "Who Moves the Farmer: Some Issues in Communication and Extension." World Food Issues. Ithaca, New York: Cornell University/NYS College of Agriculture and Life Sciences, International Agriculture Program, Center for the Analysis of World Food Issues, 1979.

Compton, J. Lin. "The Communication Process and the Mediator-Facilitator." In J. Lin Compton, Factors Related to the Role of the Primary School Teacher as a Mediator-Facilitator in the Communication Process Between the Rural Village Community and the Larger Social System in Northeast Thailand. (Unpublished Ph.D. dissertation) Ann Arbor: University of Michigan, 1972.

Compton, J. Lin. "Outsiders Can Help, But Insiders Must Do The Work: The Indigenous Specialist: A Theoretical Basis for a Practical Strategy for Rural Reconstruction." Silang, Cavite, Philippines: International Institute of Rural Reconstruction, 1973.

Compton, J. Lin. "Mobilizing the Voluntary Sector for the Community-Basing of Education and Development Programs." Community College Review, 7/1 (Summer, 1979), pp. 26-34.

Compton, J. Lin. "Indigenous Folk Media in Rural Development in South and Southeast Asia." In David W. Brokensha, D. M. Marren and Oswald Werner (Editors), Indigenous Knowledge Systems and Development. Lanham, Maryland: University Press of America, 1980, pp. 307-320.

Compton, J. Lin. "Sri Lanka's Sarvodaya Shramadana Movement: Promoting People's Participation in Rural Community Development." Journal of the Community Development Society, 13/1 (1982).

Coombs, Philip J. "What It Will Take to Help the Rural Poor." In Philip H. Coombs (Editor), Meeting the Basic Needs of the Rural Poor: The Integrated Community-Based Approach. New York: Pergamon Press, 1980, pp. 1-41.

Elkana, Joseph. "Research-Extension Links in Agriculture: A Study of Communication Behavior." In S. Molho (Editor), Agricultural Extension: A Sociological Appraisal. Jerusalem, Israel: Ketter Publishing House, 1970.

Etling, Arlen. Characteristics of Facilitators: The Ecuador Project and Beyond. Amherst, Massachusetts: University of Massachusetts, Center for International Education, 1975.

Freire, Paulo. "Extension or Communication." In Paulo Freire, Education for Critical Consciousness. New York: Continuum, 1973, pp. 93-164.

Gilbert, Elon H., David W. Norman and Fred E. Winch. Farming Systems Research: A Critical Appraisal. East Lansing, Michigan: Michigan State University, Department of Agricultural Economics, Rural Development Papers No. 6, 1980.

Harwood, Richard R. Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics. Boulder, Colorado: Westview Press, 1979.

Havelock, Ronald G. Training for Change Agents. Ann Arbor, Michigan: University of Michigan, Institute for Social Research/Center for Research on Utilization of Scientific Knowledge, 1972.

Havelock, Ronald G., et. al. Planning for Innovation Through Dissemination and Utilization of Knowledge. Ann Arbor, Michigan: University of Michigan, Institute for Social Research, Center for Research on Utilization of Scientific Knowledge, 1971.

Hunter, Guy. Modernizing Peasant Societies. New York: Oxford University Press, 1969.

Leonard, David. Reaching the Peasant Farmer: Organization Theory and Practice in Kenya. Chicago: The University of Chicago Press, 1977.

Lynton, Rolf P. and Udai Pareek. Training and Development. West Hartford, Connecticut: Kumarian Press, 1967.

Moseman, Albert H. Building Agricultural Research Systems in the Developing Countries. New York: Agricultural Development Council, 1970.

Nagel, Uwe Jens. Institutionalization of Knowledge Flows: Analysis of Extension's Role in Two Agricultural Universities in India. Frankfurt, Germany: Special Issue No. 30 of Quarterly Journal of International Agriculture, 1980.

Rogers, Everett M. "Communication and Development; the Passing of the Dominant Paradigm." In Everett M. Rogers (Editor), Communication and Development: Critical Perspectives. Beverly Hills, California, Sage Publications, 1976, pp. 121-148.

Rogers, Everett M. and D. Lawrence Kincaid. Communication Networks: Toward Paradigm for Research. New York: Free Press, 1981.

Ruttan, Vernon. Agricultural Research Policy. Minneapolis: University of Minnesota Press, 1982.

Steinberg, David I., et. al. Korean Agricultural Research: The Integration of Research and Extension. Washington, D.C.: U.S. Agency for International Development, Project Impact Evaluation No: 27, 1982.

Compton, J. Lin. "A Nonformal Vocational Education Center for Training and Extension for the Land Settlements of Northeast Thailand," A project paper for USAID/Office of Human Resources and Training, Bangkok, Thailand, 1977.

Namat, Ibrahim bin. "Pattern and Process in Residential Training for Agricultural and Rural Development: A Comparative Analysis of Four Case Studies." Unpublished Ph.D. Dissertation. Ithaca, New York: Cornell University, 1982.

Mitchell, John Joseph. "Problems and Solutions of Indigenous Knowledge System Recovery," (MPS Paper). Ithaca, New York: Cornell University, 1982.

Schaffenberger, Christine Elias. "Training Needs Assessment for Village-Level Extension Workers: An Environmental Approach." (MPS Paper). Ithaca, New York: Cornell University, 1982.

Warren, Dennis M. "Humanistic Approaches in Applied Anthropology," in Bruce T. Grindel and Dennis M. Warren, Essays in Humanistic Anthropology: A Festschrift in Honor of David Bidney. Washington, D.C.: University Press of America, 1979, pp. 115-135.

# ORGANIZATIONAL DEFICIENCIES OF TECHNICAL ASSISTANCE PROJECTS INCLUDING FSR/E: POINTS OF DEPARTURE FOR DISCUSSION[1]

Frank S. Conklin[2]

All field methodologies, including FSR/E, require an operational delivery system. The management of such delivery systems is becoming recognized as an important, if not crucial, element of many technical assistance projects. Management issues loom large because of marked differences between the participants (host country, donor, and contractor) in technical, administrative, social, cultural, and economic perspectives associated with institution building of agricultural technical assistance. A number of issues are listed here which typify management problems of implementing technical assistance projects. They are not unique to a particular country, donor, or contractor. Neither are they exhaustive. Rather, they are presented as a means for initiating needed dialogue to identify, address, and resolve such issues in time. The list was prepared from several sources, including the new book by Moris which focuses specifically upon administration of technical assistance projects overseas and experiences of this author as an end of project evaluator. Topics are separated into categories. Most issues are presented in a normative fashion to stimulate discussion. As there are more topics than time available for discussion, please identify those two or three topics which you feel are most important for discussion.

## Technical Assistance of FSR/E

1. Topic: FSR/E requires a multi-disciplinary approach with an international orientation.

   Comment: The faculty reward and incentive mechanism at U.S. universities is geared to domestic disciplinary work. The mechanism will have to be altered if long-term high quality expertise to focus upon needs of the LIC's is to be fostered (Gilbert, pp. 35-37).

2. Topic: The institution-building aspects of technical assistance promotes and employs capital intensive technology.

   Comment: A change in donor and university contractor perspective will be required before scale and type of technology being introduced are suitable both for LIC farmers and host country institutions.

## Host Country

1. Topic: The very institutions we must work with in LIC's often are unstable and lack technical and administrative capability in agriculture.

---

[1]Prepared as a discussion document for the Farming Systems Research Symposium, Kansas State University, November 21-23, 1982.

[2]Professor of Agricultural and Resource Economics, Oregon State University, and former CID Scholar/Deputy Director, Tucson, Arizona.

Comment: The situation imposes far greater administrative demands upon technical assistance teams than has been realized in the past.

2. Topic: Host countries face severe capital and personnel shortage for managing their matching share of the projects.

   Comment: Donors typically overload the limited capacity of host countries. The result usually is proliferation of parastatals which operate autonomously until donor monies terminate then die out from lack of local funds, superficial shuffling of monies to appear that something is being done by the host country, or a failure of the host country to meet the level of matching money specified by over committing existing personnel many times over.

3. Topic: The governments of many LIC's have little, if any, concern about the agricultural sector of their country.

   Comment: Grass roots development of small farmer organizations is important to generate an agricultural power base in providing a voice at the federal level for supporting the agricultural sector and to supply paraprofessionals at the farm and village level for technology testing and modification and prevent further alienation of the farm population.

Donor

1. Topic: Conditions precedent clauses of host country agreements involving host country contribution often are not enforced.

   Comment: The consequence is postponement of fiscal responsibility on the part of the host country until principal and interest payments fall due on the loans and a collapse of the fragile institutional structure fostered by the contractor.

2. Topic: Donor agencies have not incorporated productivity criteria into monitoring of project performance and evaluation.

   Comment: Donors, to date, have focused upon volume of capital through-put per unit time and contractor output levels rather than impact.

Contractor

1. Topic: U.S. training of foreign students, as currently employed, does not meet the needs of LIC's.

   Comment: U.S. training continues in the tradition of specialization which fosters an "elitist" and irrelevant cadre of professionals which, when they return home, become part of a self-serving and self-perpetuating system.

2. Topic: Land grant universities are poor in training personnel for management positions in agriculture. The case of best technicians becoming poor department heads exemplifies the case. The situation is worse for chiefs of party on technical assistance contracts.

Comment: Formal management training is needed for COP's, technicians, and host country technician counterparts who are being trained in the U.S. The type of training needs to be focused upon the specialized conditions for dealing with technical assistance on each specific project.

3. Topic: A projects' technical field team, as the contract implementing unit, is ill-equipped to serve as an effective design unit.

   Comment: A definitive plan of work should be included in a project's contract document to minimize the requirement of project planning by the technical field team.

4. Topic: Lack of administrative competence of chiefs of party of projects is all too often a major contributor to serious project problems.

   Comment: Require management skills for COP's to be on a par with technical skills.

5. Topic: It is rare for the ministry of agriculture in a host country to have much political clout.

   Comment: Contractors on technical assistance contracts need to work closely with that ministry in a host country which controls the budget for agriculture so as to (1) highlight the importance of agricultural research/extension to the economy, and (2) establish mechanisms for improving the delivery system of projects which serve agriculture.

## REFERENCES


Conklin, Frank S., and David W. James. "End of Project Evaluation for the CID/Bolivia Contract on Basic Foods Production and Marketing." October 1982.

Gilbert, Elon H., David W. Norman, and Fred E. Winch. "Farming Systems Research: A Critical Appraisal." Rural Development Paper Number 6. Department of Agricultural Economics, Michigan State University. 1980.

Moris, Jon R. Managing Induced Rural Development, IDI, Indiana University. 1981.

Whyte, William F. Participatory Approaches to Agricultural Research and Development: A State-of-the-Art-Paper. ARE Number 1, Cornell University. 1981.

Eicher, Carl K. "Facing Up to Africa's Food Crisis." Foreign Affairs. Fall 1982.

# EVALUATING THE IMPACT OF FARMING SYSTEMS RESEARCH AND DEVELOPMENT PROJECTS – A NEGLECTED ISSUE[1]

R. H. Bernsten[2]

## Introduction

In most developing countries, a substantial share of the agricultural output is produced by limited resource farm families. Typically these units rely heavily on family owned resources to raise a wide variety of crop and livestock products for home consumption and cash sales. Household production and consumption decisions are influenced by environmental factors, sociocultural values, the family's resource endowment, and existing institutions.

The farming systems research and development approach (FSRD) focuses on developing new technology to meet the needs of these households. FSR&D projects are built upon the premise that the multiplicity of factors affecting farmers' production and consumption decisions must be taken into account in the research and development process. This is achieved by scientists involving farmers not only in identifying constraints, but also in designing, testing, and evaluating potential technologies to break these constraints. Where it is determined that factors beyond the producers' control such as the non-availability of inputs, shortage of credit, or market imperfections prevent adoption, actions are taken to affect appropriate policy decisions to remove these constraints.

Increasingly, resources earmarked to accelerate international agricultural development are being allocated to support research activities that are described as following a farming systems research and development approach. In four international agricultural research centers with long-established programs, 3 the FSR&D budget rose from $3.8 million in 1975 to $8.2 million in 1980 (CGIAR/TAC, 1978). An increasing proportion of United States Agency for International Development (USAID) funds is being allocated to support research activities, rising from $84.7 million in 1978 to $143.7 million in 1981 (Crawford, 1982). While it is difficult to determine the share of these funds supporting FSR&D, a review of 1983 Country Development Strategy Statements indicated that 24 country missions expressed an interest in this approach (McDermott, 1981 in Crawford, 1982). The International Research and Development Center (IDRC), an early supporter of FSR&D, allocated $14.5 million to crop and cropping systems activities in 1981-82--the largest portion of their agriculture, food, and nutrition science budget (IRDC, 1982). Among the six World Bank supported national agricultural research and extension projects approved in fiscal year 1979, all included FSR&D as a component, compared to only one of

---

[1]Paper prepared for the Farming Systems Research Symposium, Kansas State University, November 21-23, 1982, revised.

[2]Agricultural Economist, Winrock International, Rt. 3, Morrilton, Arkansas, 72110, U.S.A.

[3]The International Center for Tropical Agriculture, the International Rice Research Institute, the International Center for Research in the Semi-Arid Tropics, and the International Institute for Tropical Agriculture.

five projects approved during the period FY 1971-76 (World Bank, 1980). Significant increases in FSR&D activities have also occurred in national programs, such as in Indonesia where the Central Research Institute for Food Crops managed 25 FSR&D field sites in 1981, compared to 2 in 1975 (McIntosh and Effendi, 1981).

The current interest in FSR&D has grown out of a valid concern that previous strategies have often failed to have the anticipated impact on agricultural development in the third world. In fact, FSR&D methodology explicitly attempts to take into account the failings of previous efforts to develop a strategy that more efficiently focuses research on finding solutions to problems facing small farmers. At the same time, it is premature to embrace FSR&D as a panacea.

> While the farming systems approach promises to better align research with the needs of small farmers in many areas, there is yet insufficient on-the-ground experience with it to determine how useful and cost effective it will be, and what its ultimate role will become. Moreover, FSR&D is not on either/or proposition. FSR complements, but does not replace more traditional discipline-oriented research. (Crawford, 1982).

Precisely because the FSR&D approach is being widely promoted in advance of significant evidence as to its effectiveness, there is a need to build an evaluation component into all ongoing FSR&D programs. The primary purpose of these efforts should be to gather information that will enable program staff to identify strategies for increasing the impact and cost effectiveness of FSR&D. If we fail to critically evaluate our FSR&D experience and learn from this, we will forsake the opportunity to make a significant contribution to development.

This paper 1) reviews the methodology of evaluation research, 2) highlights approaches that have been used to evaluate agricultural research activities overseas, and 3) outlines minimum evaluation needs in FSR&D programs. It is hoped that this overview will motivate scientists involved in FSR&D to further explore this topic in order to develop a capacity to build an evaluation component into existing and future projects.

## Evaluation Research -- Overview[4]

The evaluation research movement as a discipline is only about 15 years old. Increased attention is being paid to this subject because as resources become scarce, there is an increasing need to allocate those resources to the highest impact areas. "Social institutions whether medical, educational, religious, economic, or political are being required to provide proof of their legitimacy and effectiveness in order to justify society's continued support" (Suchman, 1967).

### Purpose

The purpose of evaluation research is to determine the results of an activity designed to accomplish some valued goal or objective (Suchman, 1967). Evaluation studies provide a basis for assessing the effectiveness of a project.

---

[4]This section summarizes concepts found primarily in (Hoole, 1978) and (Weiss, 1972).

Results of these studies can be used by policy makers to make decisions about future funding, by project administrators to identify components that require strengthening, and by field staff to assess the effectiveness of specific activities.

Attempts to develop a formal methodology recognize the need to make the judging process both accurate and objective by following the scientific method. Evaluation studies should aim at achieving a high level of reliability and validity. Reliability focuses on procedures that increase the likelihood that we accurately measure the phenomena of interest so that no matter who does the study, similar conclusions will be reached. Validity deals with the degree to which we actually measure what we think we are measuring.

Staffing

Evaluation studies may be conducted by individuals associated with the program or by outside personnel. In-house evaluations are likely to meet less resistance from program staff and may be more accurate because these people are most knowledgeable about the program. On the other hand, in-house evaluations may give biased results due to the tendency of staff to selectively collect data to show that the project is effective. Also, unless individuals assigned to the evaluation are knowledgeable about possible methodological pitfalls, an in-house study will not adequately control for extraneous effects that make it difficult to distinguish program impact from other influences. As each evaluation situation is unique, the advantages and disadvantages of alternative staffing arrangements will have to be weighed and a decision made for each specific study. In many instances, a team of both local and external participants will be most appropriate.

Types of Studies

Evaluation studies conducted during the life of the program are referred to as formative studies. Evaluations conducted after the program is completed are known as summative studies. While the implementation activities are influenced by the time horizon being considered, the same basic evaluation principles apply to both formative and summative studies.

Sponsorship

Before implementing an evaluation study, it is important to first determine who is interested in the results. Possible constituents may include policy makers, donors, administrators, and program staff. Generally, the specific focus of the evaluation will depend on the needs of the sponsor.

Identifying Program Goals and Indicators of Achievement

Programs vary in terms of breadth of focus, size, duration, complexity, and degree to which impacts can be accurately anticipated. In theory, program goals should have been defined as a part of the original planning process. If this has been done adequately, the evaluation study attempts to measure the success of the program in meeting these goals. In reality, goals are often vaguely expressed. In such instances, it will be necessary to first obtain agreement as to program goals before the evaluation study can be implemented.

To evaluate success in achieving goals, these general statements must be first translated into concrete indicators of achievement that can be measured.

This is done by framing goal statements as impact hypotheses which show the relationship between the program and an indicator of some change in behavior or condition. As was the case with goals, indicators of achievement should have been identified in the original program plan. For example, if a program goal is to reduce soil erosion in a watershed, this program impact could be measured in terms of the siltation level in the river flowing out of the watershed, before and after the program. If specific indicators were not identified previously, it will be necessary to establish relevant indicators before the program can be evaluated.

Types of Rival Hypotheses

For each impact hypothesis, there will be several rival hypotheses which may explain the anticipated impact. Cook and Campbell (1963) have identified thirty-five rival hypotheses and have classified them into four categories dealing with:

Internal validity. Are there factors that raise doubts whether the hypothesized causal relationship between the indicator of achievement and the program actually exist in the circumstances examined? For example, could the observed impacts be the results of such factors as other events occurring at the same time, secular trends, biased selection of the test group, the way in which the impact variables were measured, or losses of cases from the two groups?

Statistical conclusion validity. Could the incorrect use of statistical techniques explain the conclusions? For example, have the conclusions resulted from using too small a sample size, inappropriate levels of significance, or measures of achievement that were unreliable?

External validity. Can the observed impacts of the program be expected to be the same at a future point in time, at a different location, or when different individuals are involved? For example, can you generalize to other situations where the types of respondents and treatments are not identical or to the future since the past and future are not identical?

Construct validity. Can you generalize from operational measures to theoretical constructs? For example, do the operational measures developed to evaluate the constructs adequately represent the process, have the respondents given biased answers to please or mislead the research, or was data selectively collected to fill the expectations of the valuators?

When there is strong empirical evidence that repudiates all rival hypotheses, it is possible to conclude that the program is responsible for the observed changes.

Types of Evaluation Designs

Choosing an appropriate evaluation design is a critical decision in evaluation research. Design selection must consider the program goals, indicators of achievement to be measured, impact and rival hypotheses, available data, and the advantages and disadvantages of alternative design. The goal is to select an evaluation design that by controlling for exogenous effects (rival hypotheses), allows the researcher to conclude that the program goals have been achieved as a consequence of the program and are not the result of alternative phenomena. The three basic types of designs used to control for internal validity type

rival explanation are experimental, quasi-experimental, and non-experimental. Rival hypotheses of the statistical conclusion, external validity, and construct validity type are controlled through refinements of the basic evaluation designs described below.

Experimental designs. These designs require that a random sample of respondents is selected from the target population with a subset randomly designated as program participants and a subset excluded as controls. Data is collected with respect to the indicator of achievement variables from each group before the program is started and after it is completed. Experimental designs provide the greatest confidence in the validity of the assessment's conclusions, but must be built into the program from the beginning and may be difficult to implement.

Quasi-experimental designs. These designs generally provide less control of exogenous rival hypotheses than experimental designs. While experimental designs are more rigorous, quasi-experimental designs are more practical to implement. Furthermore, by assessing the possible rival hypotheses that could invalidate the conclusions while planning evaluation studies, the researcher can build into the quasi-experimental model modifications that will allow rejection of these alternative conclusions (Campbell and Stanley, 1963). Three types of quasi-experimental designs ordered in terms of their increasing power to support causal impact relationships are the:

1. <u>One group, multiple time series design</u>--Data to measure achievement is collected from only the treated group at several points in time--usually before, during, and after the program is implemented. Generally, the longer the time period over which an impact can be observed, the stronger the evidence that the program was effective.

2. <u>Treated and untreated non-equivalent control, pretest and post-test design</u>--In this model, information to measure achievement is gathered from program participants and non-participants at two points in time -- before and after program implementation. These two groups are considered non-equivalent because individuals were not randomly assigned to each group.

3. <u>Treated and untreated non-equivalent control, multiple time series design</u>--This design is similar to (2), but incorporates observations on both groups before, one or more times during, and after program implementation. Consequently, it is the most powerful quasi-experimental design.

Non-experimental designs. These are usually chosen as a last resort since they control for fewer of the rival hypotheses which could explain program impact than do experimental and quasi-experimental design. Yet if carefully undertaken, evaluations using these designs can provide insights into program impact and are particularly appropriate strategies for preliminary evaluation of ongoing projects. Three types of non-experimental design are the:

1. <u>One group, post-test only design</u>--Information is only collected on the conditions that exist after the program has been completed. No formal attempt is made to assess the program situation.

2. Treated and untreated non-equivalent control, post-test only design -- Data to assess program impact is collected after the program is completed. In addition to program participants, a sample of similar non-program participants is selected as a control against which the program's impact on participants is compared.

3. One group, pre-and post-test only design--Data on the agreed upon program achievement indicators are collected at two points in time--generally before and after the program is implemented. If baseline data was not originally recorded, proxy measure for the before situation, such as recall estimates from participants, may be used with caution.

Data Collection

The data to be collected will be suggested by the hypotheses to be tested. The researcher must be resourceful and consider all possible sources of information, including persons knowledgeable about the program, program participants, records maintained by the staff, reports completed, site visits to observe concrete developments, and government statistics.

Analysis

Once data has been collected, it must be assembled, analyzed, and interpreted in a meaningful way. In addition to assessing the degree to which program goals were achieved, it should incorporate the evaluator's observations as to factors that contributed to the success, obstacles incurred, ways in which the project could have more effectively achieved program goals, and similar insights. Finally, the report should explicitly identify data problems or other factors that could influence the confidence the evaluator has in the conclusions reached.

Policy Process

Results from evaluation assessments should be considered as one of many sources of information about a program's effectiveness. If properly executed, these results should provide an objective evaluation of the program's impact and a basis for decisions about future program implementation. Evaluation studies are frequently resisted by individuals associated with a program out of a fear that the assessment will produce threatening results. In anticipation of this response, it is important that the evaluation has the support of the administrative structure, the purpose and methods are clearly outlined from the start, and program staff is provided an opportunity to participate in the evaluation team or at a minimum, a sincere effort is made to solicit their observations regarding program impact.

Highlights of Recent Evaluation Studies

Numerous efforts have been made to evaluate the impact of research activities in general and farming systems research and development specifically. A selection of recent and ongoing studies are reviewed to illustrate the diversity in approaches followed. In addition, these studies provide examples of how evaluation research theory has been applied in practice. Finally, aspects of these studies that are particularly relevant for institutionalizing evaluation in FSR&D programs are highlighted.

Stripe Review (CGIAR)

In 1978, the Consultative Group for International Agricultural Research Technical Advisory Committee conducted a review of farming systems research and development at International Agricultural Research Centers (CGIAR/TAC, 1978). The review was limited to established crop-oriented FSR&D program at the International Institute for Tropical Agriculture, International Centers for Research in the Semi-Arid Tropics, the International Rice Research Institute, and the International Center for Tropical Agriculture. Activities included a review of program documentation, visits to each center, and a workshop held in February, 1978 to discuss findings and to prepare a draft report. Terms of reference included reviewing the objectives and scope of FSR&D activities, relationship between centers and off-campus activities and methodological issues.

The study is a useful review of these programs and important issues in FSR&D, but devotes only one page to "criteria for assessment" and includes almost no quantitative data on impact. The report suggests adoption of new technology and methodology by national institutions is one logical criterion for assessing centers' FSR&D programs, including such factors as potential impact of developed systems, degree of adoption, impact on the organization of national research institutions, training and planning, number of persons trained and subsequent activities, and published papers (CGIAR/TAC, 1978).

Costs and Benefits of Agricultural Research: State of the Arts and Implications for CGIAR

At the request of the CGIAR, Schuh and Tollini reviewed existing methods for assessing and monitoring the impact of agricultural research and its cost effectiveness (Schuh and Tollini, 1978). Particularly useful is the introductory discussion on the difficulties inherent in evaluating research arising from the fact that research is conducted because there are unknowns in the system. In addition, they note problems with defining and measuring research inputs and outputs and the effect of economic policy on farm level adoption. Acknowledging that increasing output is the most widely operational goal of agricultural research, Schuh and Tollini also discuss the role of research in improving product quality (e.g., stability, nutrition); conserving inputs (more fertilizer responsive and drought resistant varieties); and the interactions between improvements in the marketing system, input supply industries, and economic policy on farm level adoption of new technology and producer welfare. While technological change is normally considered as positive, negative side effects on income distribution, employment, and the environment must often be considered in assessing research impact.

The review of methods and procedures for evaluating agricultural research focuses on traditional ex-post economic models and ex-ante procedures for setting research priorities. In the context of FSR&D evaluation, these models are probably too macro oriented and quantitatively sophisticated to be institutionalized into ongoing national FSR&D programs.

Cropping System Working Group

In 1981, Asian Cropping Systems Working Group representatives from the Philippines, Nepal, Sri Lanka, and Indonesia agreed to undertake studies in their respective national programs to evaluate changes in productivity at cropping

systems research sites (Impact Assessment Committee, 1981). Acknowledging that productivity changes are only one anticipated consequence of FSR&D and that adoption will be dependent on extension and other support activities, an attempt to measure program impact on production was initiated.

To insure relevance, the studies were designed in each country by an interdisciplinary team of national program staff, keeping in mind the need to meet country program objectives; that the methodology must be simple and capable of being implemented quickly; and given high priority by program economists.

The guidelines for implementing these studies established four indicators of achievement to be evaluated: the extent of adoption of specific improved practices that had been identified through on-farm trials and recommended to farmers; and changes in output, income, and employment at the farm level. In addition, data was collected on factors thought to influence adoption and non-adoption of recommended practices. Researchers from each country conducted their impact study at one research site where spontaneous adoption of improved cropping systems practices had occurred. Data for assessing impact was obtained by interviewing a random sample of 10% of the farmers in the target area, assembling secondary data from previous studies, and interviewing extension personnel.

Analysis focuses on evaluating differences between adopters and non-adopters with respect to output, income, labor requirements, and socio-economic characteristics. These studies have been completed and are in the process of being published by the International Rice Research Institute.

United States Agency for International Development

Since November 1979, the Office of Evaluation, Studies Division, has been evaluating the impact of major program activities in general, including research projects. Over fifty program evaluation discussion papers, program evaluations, project impact studies, and special studies have been published. USAID staff have also collaborated with other bilateral aid agencies to share their methodology development experiences.

Comprehensive review. A recent USAID sponsored ex-post study of selected agricultural research projects reviewed historical trends in agricultural research, identified factors affecting USAID's past and present research portfolio, assessed 48 research projects based on data gleaned from monitoring reports, and made recommendations. This report provides considerable background information and noted problems encountered in various projects. Unfortunately, the study failed to achieve its goal of identifying a pattern in these experiences to "serve as a basis for forming judgments and hypotheses about program and project efficiency and performance, effectiveness in reaching stated objectives, and impact on development goals" (Crawford, 1982) due to the inadequate quantity and quality of data which was obtained from the standard evaluation document. In conclusion, the report suggested that the desired objective could more likely be achieved by in depth issue-oriented studies, conferences of experts on specific sectors or issues and policy oriented ex-post impact evaluations such as those currently being undertaken by USAID.

Impact assessment studies. Of USAID's 32 completed impact studies, eight evaluated research projects, two of which involved FSR&D. Each project was evaluated during a three- to four-week in-country visit by a multidisciplinary

team of reviewers, including one or more AID staff members. Findings of the studies are summarized and integrated by Murphy (1982) in terms of:

1. Macro-economic and policy environment, including the host country commitment to research, capacity of the country to make available timely inputs at reasonable prices, and the availability of efficient marketing channels.

2. Institution building and training, including appropriate location of the project in the country's administrative structure and within the research community; and the success in training and keeping in place trained staff.

3. Technology generation and transfer, including the appropriateness of the research project with respect to the needs of the country, the adaptation of research to farmers' conditions, and the dissemination of findings to farmers.

4. Impact on households, including agronomic and socio-economic impact.

The project impact evaluation report entitled Central America: Small-Farmer Cropping Systems (Hopgood, et. al., 1980) illustrates how evaluation research theory can be operationalized in assessing an FSR&D project. This study was conducted by a multidisciplinary team of six scientists with Latin American experience who spent three weeks in Costa Rica and neighboring countries involved in collaborative research with Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) -- the institutional home of the project being assessed. First the team clearly identified the objective of the USAID grant to CATIE as being to create a coordinated regional research approach for improving farming systems of small farmers in Central America. Then they proposed to evaluate the program in terms of its impact on research and training; national, regional and international institutions; and small farmers. A matrix of key questions was developed, answers to which provided a historical description, and a qualitative and quantative assessment of success. For example, to measure the effect of the project on training, data was collected on such items as the number of FSR&D courses offered, students taking FSR&D courses, and faculty indicating a FSR&D specialty -- before and after the project. To measure the impact on research, the authors documented the shift in focus from station to on-farm trials, from a disciplinary to a production (i.e., annual crops, perennial crops) emphasis, and from a disciplinary to an interdisciplinary team approach. Even though the project was not expected to have a significant impact on producers because it was only recently established, the team interviewed farmers cooperating in on-farm testing to evaluate their knowledge of the project, adoption of recommended technology, and the yield after adoption.

The team collected the required information by analyzing secondary data, financial records, and reports; by interviewing donors, CATIE administrators, project staff, staff of collaborating institutions, and farmers; and through direct observation at field sites. Each major section in the report includes a competing explanation (rival hypothesis) as to how the observed impacts could have resulted as a consequence of factors not related to the project. The report also includes observations as to how specific activities (e.g., cooperating farmer selection, integration of macro-economic and sociological studies) could have been implemented more effectively, and extenuating circumstances that affected the success of the project in certain cooperating countries. Finally, the report discusses the deficiencies of "ex post" evaluation research where it

is necessary to reconstruct the pre project situation.

Heifer Project International

Over the past four years, Heifer Project International (HPI) has been developing a simple and practical project evaluation methodology (Schmidt, 1982). The HPI evaluation strategy suggests building into each project four types of evaluations over the life of the activity: project progress reporting, program review, formative evaluation, and summative evaluation. These evaluations progress from less to more detailed, comprehensive, time consuming, and expensive. HPI strongly supports the concept that local staff participation in planning and execution is critical to effective use of the information generated by the reviews. Consequently, a standardized but flexible review format has been developed so that the evaluations can be largely done at the project site by project staff. The standardized design also guarantees that similar information is collected in all reviews, making possible comparisons across projects. Finally, HPI emphasizes that "project results should be planned for and deliberately worked towards. If a project is only designed in terms of activities that are to take place, the bases for evaluation can only be defined in terms of activities, problems, and unplanned results." While HPI projects are more extension in contrast to research focuses, their experience with implementing evaluation studies in third world projects is still relevant.

World FSR&DReview

In 1978, the Consortium for International Development was awarded a contract by USAID to study existing FSR&D projects and to write a set of methodological guidelines (Shaner, et al., 1982). This comprehensive study is a synthesis of documents and information gathered on FSR&D projects around the world, and includes a three-page general discussion on evaluation. Three types of evaluation studies are briefly described: (1) built-in evaluations for providing periodic appraisal over the program's life, (2) special evaluations conducted in response to problems, possible program revisions, and/or interesting happenings, and (3) impact evaluations conducted after the project is completed. The built-in approach is judged most useful as it provides an opportunity for corrective action. In addition, the authors reviewed USAID's Logical Framework--an evaluation procedure incorporated into program design that identifies and relates goals, purposes, outputs, and inputs--and concluded this process produces better project designs. This study is an extremely useful review of FSR&D, but the brief treatment of evaluation suggests researchers around the world have given little attention to this issue.

Minimum Elements in Evaluation of Impact

The overview of evaluation research methodology identified conceptual issues that must be dealt with in attempting to assess impact in FSR&D. Together with the evaluation experiences reflected in the approaches reviewed and points of view reflected in correspondence from a number of individuals involved in FSR&D,[5] an attempt is made to identify minimum evaluation procedures that should be incorporated into ongoing FSR&D projects.

---

[5]See Acknowledgement.

## Evaluation Needs in FSR&D Projects

Evaluation approaches differ significantly, depending on such factors as who needs the information, the purpose of the study, and staff, money and time available to conduct the study. Consequently, priorities must be set which take into consideration these factors.

As most FSR&D programs are relatively new and still evolving, priority must be given to developing formative evaluation strategies. These early reviews should serve as a mechanism for feeding back to the staff information that can serve to strengthen future program activities directed at achieving agreed upon objectives. Information gathered for formative evaluation can also serve as part of the data base for summative studies. Traditional benefit-cost studies should be carried out on selected programs, but initiated as special studies and not conducted routinely (Byerlee, personal correspondence).

In most FSR&D projects, resources available for evaluation are limited. Under these circumstances, evaluation procedures must be developed that can be routinely executed by local staff in a short period of time at a low cost. Only if these criteria are maintained, will it be possible to build program strengthening evaluation activities into all programs where FSR&D strategies are being implemented.

## Institutionalizing Evaluation

To have a meaningful impact on FSR&D activities, evaluation must be institutionalized within the program and not initiated as an after-thought or in response to external pressure. In the national program, a multi-disciplinary team of 3-4 individuals--drawn from the research and extension staff--could be given the responsibility to develop a formative evaluation system and see that it is implemented. By assigning leadership to a permanent group, the resulting studies are most likely to be comparable over time and space, develop in quality, and required less time to complete as the team gains experience.

Evaluation studies should be planned to coincide with specific phases in project life when decisions are to be made about future activities (Philipp, Zandstra, personal correspondence). Most important, they must be anticipated and planned for from the beginning of the program to avoid the common problem of having to evaluate preprogram conditions retrospectively.

## Specifying Goals in FSR&D

There is considerable disagreement as to whether FSR&D is a perspective or a specific method for conducting research (Byerlee, et. al., 1982). This debate will probably become increasingly intense as more individuals become involved in FSR&D activities. Yet, because FSR&D will be conducted under a great variety of environments, institutional, political, and socio-economic settings, it seems unrealistic to set out a detailed criteria against which all FSR&D projects are to be evaluated. The critical issue is not whether a program conforms to a predetermined set of steps, but that the technology developed works under farmers' conditions to increase farmers' welfare--regardless of whether it was developed in a lab, on the experiment station, or in farmers' fields. An assumption in the FSR&D approach is that success can best be achieved by testing technology in on-farm trials (Herdt, personal correspondence). Farmers' field trials may be required when working in complex farming systems, characterized by environmental diversity, a large number of crops grown, and a high degree of crop-

livestock interaction (Hart, personal communication). However, on-farm trials may be inappropriate if technologies are not far enough developed (Knipscheer, personal correspondence) or the crop of interest is grown in a monoculture under environmental and managerial conditions similar to those on experiment stations.

In planning FSR&D programs, it is important that program goals tailored to the specific research problems under consideration are clearly defined, along with indicators of achievement. If this is done, it will be possible to build into the program activities to collect data to measure the impact of the program in terms of quantitative and qualitative indicators of achievement.

In defining specific anticipated impacts as a basis for working toward results, we are faced with the dilemma that research focuses on identifying solutions to problems that to date have been elusive. Research stakes out new territory or it's not research (Shaner, personal correspondence). How can we identify specific indicators of success before the problems facing farmers are identified in the diagnostic stage of FSR&D? The underlying resistance to setting specific targets is often rooted in the fear that if these are not met, the program will be judged a failure. One alternative would be to postpone establishing specific indicators of achievement until 6-12 months after the program is initiated (Baker, personal communication). Alternatively, specific targets initially identified in the planning stage could be revised periodically to reflect experience to date, a strategy that would be consistent with the evolutionary and flexible nature of FSR&D aimed at addressing farmers' real problems (Galt, personal correspondence). This approach may be particularly appropriate in formative evaluations intended primarily for internal use because there would be less of a penalty for missing the mark.

## Measuring Costs

It should be relatively easy to measure inputs into FSR&D programs, since they have budget implications. Inputs that should be measured include salaries paid, months of staff involvement, physical inputs used (vehicles, chemicals, seed), and similar factors. In addition, it may be possible to estimate costs incurred by farmers involved in FSR&D. An up-to-date accounting of actual resources expended to implement a FSR&D program should be maintained for several reasons. First, cost information will enable the program staff to develop accurate budgets for planning subsequent FSR&D programs. Second, estimates of the cost of specific research activities such as surveys, on-farm trials, data analysis, etc., will provide management with a tool for identifying high cost activities for which more efficient approaches should be developed. Finally, this information will facilitate formal benefit-cost assessment at some future date.

## Measuring Benefits

Ideally, we would like to measure impacts in terms of final results. Alternatively, we can measure the process in terms of activities and outputs that we believe contribute towards achieving final results (Shaner, 1980). Final results generally are captured by producers and consumers, whereas process impacts affect institutions. Both measures of final results and process effects should be monitored throughout the program and should not be postponed until the program is completed.

Final results. Measuring final results is difficult because we must first identify the relevant final results to monitor and then devise a procedure to measure the agreed-upon phenomena. If we agree that improving producer welfare is the ultimate objective of FSR&D, we can consider several possible indicators of achievement:

1. Adoption -- The easiest and most agreed upon measure is probably adoption of recommended practices. Hildebrand's index of acceptability for different components of the technology package combines the percent of farmers using a component times the percent of their land to which it is applied, divided by 100 (Hildebrand, 1979). He suggests that farmers may adopt for reasons other than yield or income. If they use the technology, for whatever reason, they must think it worthwhile (Hildebrand, personal correspondence). Because partial adoption is also a significant impact, it is important that components be evaluated and not complete packages (McIntosh, personal correspondence). While adoption is an important factor to measure, reasons for non- adoption will provide valuable feedback to FSR&D researchers, and this information should be systematically collected (Banta, personal correspondence).

2. Production parameters -- Adoption of new technology may affect yield, yield stability, cropping intensity, area cultivated, and/or permit constant output with fewer inputs. In some instances interactions may be important. For example, yield increases may allow a farmer to meet subsistence food needs by planting less of that crop so more time can be spent on off-farm employment (Galt, personal correspondence).

3. Income -- Changes in net returns for a single enterprise or total farm income is a more comprehensive measure of impact than adoption or the production parameters. In situations where the main family owned resource is labor, changes in daily returns to family labor (gross returns minus all cash costs, divided by family labor) is an important impact to measure.

4. Standard of living -- There is some merit in considering indicators that reflect total well-being. If new technology is adopted and increases farm and/or non-farm income opportunities, this should be reflected in improved living standards such as purchases of tin roofs, motorcycles, radios, land, and similar consumption and investment behavior (Barker, personal communication).

One difficulty with all of these final effects is that it may be difficult to isolate program impact from rival hypotheses. For example, adoption indices may also be greatly influenced by input price changes that may or may not have been influenced by project activities. Since production parameters such as yields are greatly affected by weather, the years chosen for measuring the before and after situation are critical (Galt, personal correspondence). Often income measures are influenced by price changes such as in a Philippines study that showed adoption cause yields and net returns to increase, but real income fell due to more increase in input and consumer prices (Herdt, personal correspondence).

It is clear that no single indicator of achievement will accurately reflect final results. It is probably necessary to use several measures in combination.

In addition, rival hypotheses can be somewhat controlled by using an experimental or quasi-experimental design. Finally, information about such exogenous factors as weather and government policies should be included in the historical record and examined to evaluate rival hypotheses. At the same time, a dynamic FSR&D program may actually be able to claim credit for policy changes that resulted from bringing specific constraints to the attention of policy makers.

The process. FSR&D is an approach to agricultural development that attempts to strengthen specific research and development processes. Implicit is the assumption that success will lead to more relevant research output that will in turn enable farmers to improve their welfare. Accepting this hypothesis as valid, it is possible to measure the success of a FSR&D program in meeting process objectives.

1. Multidisciplinary interaction--A team approach is advocated because farmers' problems are typically beyond the grasp of a single discipline. Consequently, by monitoring the disciplinary mix that actually participates in various activities, such as planning diagnostic data collection and interpreting the results; designing, evaluating and interpreting field trials; and similar activities, we can evaluate the degree to which this process objective is achieved.

2. Farmer involvement at each research stage--Farmer involvement is needed to insure that research priorities reflect farmer's needs. This process objective can be measured by monitoring formal and informal contacts between farmers and researchers. For example, by collecting information on how, how often and how many farmers participate in diagnostic activities, designing trials, and evaluating trials, it is possible to evaluate the degree of farmer involvement.

3. Research-extension communications--Where research and extension activities are separate and uncoordinated, interagency cooperation can increase the effectiveness of both units. Success in strengthening research-extension communications could be measured by, for example: the number of meetings between research and extension staff, success in staffing programs with combined research-extension teams, and related efforts that we believe lead to more rapid diffusion of technology.

4. Intermediate outputs--In many countries there is a shortage of trained field staff, extension publications and similar resources. FSR&D programs often provide staff and extension training, produce bulletins and participate in similar activities as means through which FSR&D efforts can be made more effective. Data on the number of staff trained, bulletins produced, etc., would indicate the success achieved in meeting these process objectives.

5. Research priorities--As a consequence of FSR&D activities, new and previously unrecognized research issues should surface, resulting in a shift of focus in the basic and/or commodity research programs. Impact on research priorities could be measured in terms of such factors as changes in breeding objectives and the problem focus of field trials. For example, suppose pre-program weed control research included only herbicide screening trials. As a result of FSR&D work, the non-availability of herbicides at the village level, the high cost and the

likelihood of damaging other crops in the farmers' cropping pattern are identified as constraints. In response the breeder makes screening for early seeding vigor a high priority and the agronomist initiates spacing, and/or pattern trials directed at controlling weed growth. Documentation of significant changes in research priorities such as these would provide an indication of the FSR&D program's impact.

6. External constraints--One of the characteristics of FSR&D is that it takes a holistic approach in trying to understand farmers' problems. Typically numerous external constraints will be identified such as the non-availability of physical inputs, weak market structures, and the non-availability of improved seed. If a FSR&D program is actually development oriented, it must accept responsibility for not only identifying these constraints, but also removing those that are within the project's capacity. For example, if improved seed is not available, a small multiplication plot could be established. In addition, it must make the necessary effort to link with the responsible institutions and policy makers to see that limiting constraints beyond the direct control of the program are removed (Zandstra; personal correspondence). Identifying efforts and successes in removing external constraints would provide a qualitative measure of success in achieving this process objective.

The type of data required to document these and other processes that are identified as objectives in a national FSR&D programs would require minimal time and effort to collect and would provide project managers with useful indicative information. As with the final results, it will be difficult to isolate program impact from rival hypotheses. Furthermore, it is difficult to assess the value of specific process successes. For example, while training and bulletins are part of the program's record of achievement, a high output of these intermediate goods does not necessarily correlate with the relevance of results to farmers (Byerlee, personal correspondence). In the same vein, a study in Northeast Thailand showed a high correlation between farmer adoption and the technical knowledge of the agent--although all agents had attended the same training program (Banta, personal correspondence). In addition, it is difficult to assess the quality of multidisciplinary interaction and farmer involvement.

If taken alone, process indicators of achievement are unlikely to provide convincing evidence of an effective FSR&D program. On the other hand, in the long run strengthening processes may have a greater impact on development than final results measured during project life because these changes may lead to a transformation of the research and development system. Thus, they should be articulated as program goals, measured, and evaluated as part of program impact record.

## Summary and Conclusion

FSR&D strategies are rapidly being adopted throughout the third world. These programs should be encouraged to evolve in response to country-specific resources and needs. In order to provide a better basis for judging the successes and weaknesses of these programs and various methodological approaches, an evaluation component should be integrated into each project. The evaluation strategy can best meet project needs if it is designed by local staff to generate information needed to strengthen the ongoing project.

Initial attempts to evaluate impact in a FSR&D project must be simple, exploratory, and flexible because there are numerous methodological issues yet unresolved. At the same time evaluation must be planned into projects so information can be collected from the beginning that will reflect changes that occur over time. Only through field experience will it be possible to improve our capacity to evaluate FSR&D projects. Initially, assessment should be comprehensive and monitor both final results and the process itself. While quantitative data may be more desirable, qualitative insights can also contribute toward better understanding the impact of FSR&D programs.

ACKNOWLEDGEMENT

In preparing this paper, approximately 30 individuals with FSR&D or evaluation experience were asked to comment on several issues related to impact evaluation. The author acknowledges the written responses, documents sent, telephoned comments, and ideas from discussions provided by the following individuals: Frank Baker, Gordon Banta, Randy Barker, Joseph Beausoleil, Jim Bemis, Derek Byerlee, Bob Hart, Robert Herdt, Peter Hilderbrand, Henk Knipscheer, Josette Murphy, Jerry McIntosh, Luis Navarro, Michael Patton, John Pendleton, Dwight Perkins, Perry Philipp, Bill Polk, Armin Schmidt, Jon Skovlin, William Shaner, and Hubert Zandstra.

## REFERENCES


Byerlee, D. L., Harrington, and D. L. Winkelman. 1982. Farming Systems Research: Issues in Research Strategy and Technology Design. Paper presented at the Annual Meetings of The American Agricultural Economics Association; Loga, Utah, August 1-4.

Campbell, D. T. and J. C. Stanley. 1963. Experimental and Quasi-Experimental Designs for Research, Rand McNally, Chicago.

CGIAR/TAC. 1978. Farming Systems Research at the International Agricultural Research Centers. World Bank, Washington, D.C.

Cook, T. D. and D. T. Campbell. 1976. The Design and Conduct of Quasi-Experiments and True Experiments in Field Settings in M. P. Dunnette, ed. Handbook of Industrial and Organizational Research, Rand McNally, Chicago.

Crawford, Paul R. 1982. AID Experience in Agricultural Research: A Review of Project Evaluation. AID Program Evaluation Discussion Paper No. 13, USAID Office of Evaluation, Washington, D.C., May.

Hobgood, H. H., R. Bazon, R. Ehrich, F. Escabar, T. Johnson, and M. Lindenberg 1980. Central America: Small Farmer Cropping Systems. USAID Project Impact Evaluation No. 14, Washington, D.C., December.

Impact Assessment Committee. 1981. Assessment of Changes in Productivity at Cropping Systems Research Sites. 12th Cropping Systems Working Group Meeting, Burma, December 8-13 (mimeo).

International Research and Development Center. 1982. Annual Report, 1981-82, Ottawa, Canada.

Murphy, Josette. 1982. Agricultural Research and Development: The Findings of Eight Impact Evaluations. Background paper, Workshop on the Impact of Agricultural Research, Leesburg, Virginia, AID Evaluation Working Paper No. 45, Washington, D.C., June 14-17.

McIntosh, J. L., and Suryatna Effendi. 1981. Indonesian Farming Systems Research and Development. Central Research Institute for Food Crops/IRRI, Bogor, Indonesia.

Schmidt, A. L. 1982. Heifer Project International Evaluation Manual (Draft), Little Rock, Arkansas, July.

Schuh, G. Edward, and Helio Tollini. 1978. Costs and Benefits of Agricultural Research: State of the Arts and Implications for CGIAR. Paper prepared for the Consultative Group for International Agricultural Research (CGIAR), Washington, D.C., October.

Shaner, W. W. 1980. Issues of FSR Evaluation. Notes for a talk on FSR&D presented at a OICD/USDA conference, Washington, D.C., December.

Shaner, W. W., P. F. Philipp, and W. R. Schmehl. 1982. Farming Systems Research and Development. Westview Press, Boulder, Colorado.

Suchman, E. A. 1967. Evaluation Research: Principles and Practices in Public Service and Social Action Programs. Russell Sage, New York.

Weiss, Carol H. 1972. Evaluation Research: Methods of Assessing Program Effectiveness. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

# INCORPORATING NUTRITIONAL CONSIDERATIONS INTO FARMING SYSTEMS RESEARCH

William P. Whelan[1]

Farming systems research projects have certain similarities with agricultural and rural development projects. This is not surprising given the fact that farming systems research projects essentially constitute a subset of the broader set of agricultural and rural development projects. In at least one important respect, however, they have what appears to be a striking similarity: most on-going farming systems research projects do not explicitly consider nutrition and/or health as integral parts of their farming system research, in much the same way that agricultural and rural development projects generally do not explicitly consider nutrition goals in project identification, design and assessment. This would not be surprising were it not for the fact that national and international institutions have recognized in recent years the potential for reducing protein-energy deficiencies through projects designed to improve the level of living of rural dwellers. The question being addressed here today is how might nutritional considerations be incorporated into farming systems research projects, if indeed we can suppose that reducing protein-energy deficiencies is an agreed upon objective to pursue.[2] The strategy to follow, which will accomplish this objective, and the variable(s) to use in order to do so should be the focus of our discussion here today.

## Ex Ante Analysis of the Nutritional Impacts of FSR

It can usually be assumed that successful agricultural/rural development/farming systems research projects seek to accomplish the dual objectives of raising rural levels of living and improving the aggregate food situation by following strategies which increase agricultural output and employment and, therefore, incomes in rural areas. Incomes, in turn, are viewed as providing the key to the triune goals of higher levels of living (particularly for the poorest of the poor), economic development and the achievement of the demographic transition. The critical empirical question is do the increases in output and income which result from projects improve the nutritional status of individuals who are malnourished? As Pinstrup-Anderson points out so well, one would expect the results to depend on changes in food availability and/or changes in food distribution, i.e., allocation of food available. Undoubtedly, some projects will expand and others will reduce the quantity of food available. Moreover, the nutritional composition of the available food may be changed either by changes in the relative amounts of the various commodities available in the diet, through perhaps crop substitution, or by changes in the nutritional composition of the individual commodity or commodities which compose the food available. The allocation of increased food availability to families with malnourished members and, ultimately, the intra-household distributional apparatus

---

[1]Assistant Professor, Agricultural Economics and Marketing, Cook College, Rutgers University.
Prepared for discussion at the Symposium "Farming Systems in the Field," Kansas State University, Manhattan, Kansas. November 21-23, 1982.

[2]For a discussion about why adequate nutrition should be an objective of development per se, see for example, Streeten (1979).

are also crucial factors which determine whether a farming systems research project's "success" means in fact that hungry people are getting better nourished. These "complications" which prevent one from readily accepting the implicit assumption that more food and higher incomes means less actual hunger can be seen in Figure 1, which depicts the relationship between a project and its nutritional effects.

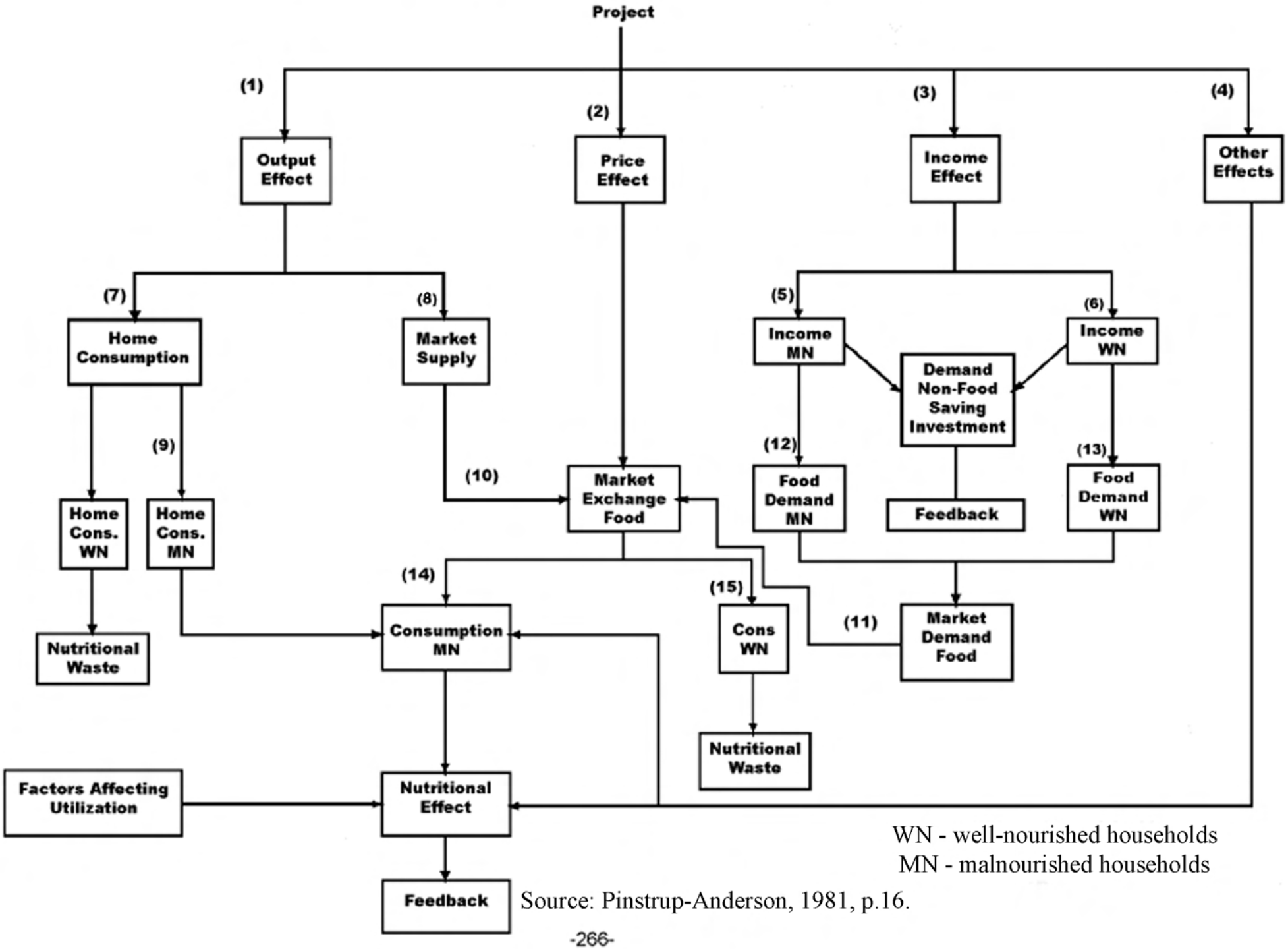
If one is to concede that output and income improvement in and of themselves are not sufficient to demonstrate that the nutritional profiles of the malnourished are improving, then one faces a dilemma in choosing a strategy. Does one choose a project willy-nilly that improves incomes and/or output and puts on blinders that block out the possibilities alluded to above, or does one look for some means of determining a strategy which minimizes the possibility that income and/or output improvements will have a perverse effect on the nutritional status of the malnourished? It is reasonable to suppose that the latter strategy is preferred to the former and that to be of most practical value some attempt should be made to provide some useful information ex ante. This view is expressed by Abalu and D'Silva when they make the following statement about improving cropping systems in Northern Nigeria:

> "Considerable research on farming systems would be needed to ensure that appropriate farming systems evolve in the future. This research must emphasize the present status of farming systems in the area and their potential for improvement. The research effort must deal with the dynamic nature of the farming system and be done from the "bottom up." This underscores the need for the research to be multidisciplinary and for the social scientist to play not only an ex post but also -perhaps more importantly -ex ante role in the research effort."

Moreover, the reality is such that a nutritional perspective, if considered at all, is most unlikely to engender a great deal of support in the initial stages of the design of a farming systems research project. The need is, therefore, to define a suitable variable or variables which will provide useful information in the strategy design phase and be economical to obtain. If data for these variables are costly to obtain and if the analysis is also expensive, then there is presumably a greater risk that explicit attention to nutritional considerations in farming systems research will be sacrificed when budgetary exigencies prevail. If, however, they are cost-effective, then they have a greater chance of being incorporated into the design of new farming system research projects, even those with little concern for nutritional considerations.

What characteristics then might such a variable have to be "useful" in the strategy design stage? I suggest that the variable must satisfy at least four requirements, the first of which is that it would have to distinguish between groups of different nutritional status, which are likely to be effected most directly by the farming systems research project. The second requirement is that it would have to allow for examining whether some correlation exists between different nutritional status groups and some indicator of the food and nutrition benefit-incidence to these groups. Third, the information used to represent the variable must be easily and quickly obtained prior to or during the strategy design phase. Fourth, the information must have acceptable levels of accuracy.

Illustration of linkages between policy/project and nutritional effects




WN - well-nourished households
MN - malnourished households

Source: Pinstrup-Anderson, 1981, p.16.

Level of Nutrition: The Malnourished and the Well Nourished

Among the possible variables which fulfill the criteria pertaining to identifying groups of different nutritional status, the one that immediately comes to mind is one that distinguishes between the malnourished and the adequately nourished. If one were to define a variable on this basis, the immediate question which arises is what the appropriate unit of analysis is: the individual, the household, or some other social grouping? Although one might like to look at individuals who are mal-nourished, the individual as a unit of analysis poses great difficulties both in terms of facility, accuracy, and expense of data collection. The household would appear to be a more appropriate unit of analysis, given the fact that most other project data will be collected on a household basis; however, problems arise when attempting to define a malnourished household.[3] Upon which of the following possible criteria is a household to be classified as malnourished: over 50 percent of the household members malnourished, everyone in the household malnourished, a minimum of one in the family malnourished, etc.? Although, in principle, the idea of defining these malnourished households is sound, I suspect that there would be some difference of opinion as to how actually to do so. Moreover, how meaningful would changes in nutritional status be even if agreement could be reached upon one definition? If one were to use the definition which was based upon over 50 percent of the household members malnourished, could one justify saying at some later period that the household was no longer "malnourished" because only 25 percent of the family was now malnourished?

Whichever definition of malnourished is selected, there will be the need to make some ex ante nutritional assessment in order to identify who are the malnourished and what their characteristics are. Theoretically, anthropometric measurements could be taken and/or some dietary intake survey could be made. Despite the inherent value of both these approaches, however, there are several factors why they might not be practicable. First, unwillingness by some to submit themselves to anthropometric measurements, e.g. young children resisting the use of skin fold calipers, may result in dubious coverage of the particularly relevant age and sex categories. Dietary intake studies, on the other hand, may be problematic because of the cost associated with the great necessity to pay close attention to detail. Consider what is involved in measuring intake amounts, and one will acknowledge the problems in doing so. For example, if farm households in low-income societies are usually privy to a relatively diverse array of food sources: food from own production, food purchases from the retail market, food from in-kind wages paid, food "eaten out," either purchased or non-purchased, food gifts, food loans, and repayments of food loans, then coverage of nutritional intakes from only those sources perceived to be most important may result in significant inaccuracies. Other inaccuracies are likely to result due to memory lapses if recall of any length of time is involved, memory errors if the individual provides information about the volume of food consumed which the enumerator has not actually been able to observe, and conversion of foods ingested to their nutritional equivalency.

With regard to this latter issue of the measurement of food in terms of nutrients and energy, one should keep in mind that the nutritional composition

---

[3]I will assume henceforth that the household is the relevant unit of analysis. However, there are likely to be contexts in which the household is inappropriate. In all cases, the most appropriate unit of analysis should be used.

of local diets are not well understood. The conversion factors used are usually highly aggregative and are often based on only a few observations.

Even if the dietary surveys are exhaustive in their coverage of sources and accurate in their estimation of the nutritional values of food received by consumers, there still remains the problem of defining the requirements to which the intake levels themselves will be compared. This would not be a problem were it not for the simple fact that the nutritional needs of individuals are not well understood. Currently available data on the protein and energy requirements of populations in developing countries are still fragmentary and seriously inadequate, and even if accurate averages of either requirements or recommended intake levels were obtained, they would not help to ensure that proper focus is placed upon those for whom the averages are still too low. Perhaps of even greater importance is the fact that the individual "requirements" upon which they are based have considerable variation for the individual depending upon the complex array of environmental factors which he or she faces. Moreover, "required" intake needs and "recommended" intake needs are inherently different, and these differences can blur their distinction when attempts are made to assess the nutritional status of a population group or segments of a population group.

Level of Nutrition: Subsistence Potential Ratio

I have just attempted to explain the problems associated with providing highly accurate measurements of who the malnourished are through the two principal approaches of anthropometry and dietary intake methods. It is undoubtedly more difficult to provide accurate ex ante measures such that they are useful in the strategy design phase than to provide them ex post, if only because it takes time to gain the trust of those being studied. However, there are variables which serve as substitutes for the functional categories of the well-nourished and the malnourished.

Pinstrup-Anderson has suggested income as being a useful and suitable substitute. There are three associated problems with use of this variable in an ex ante context, however. First, the measurement of income most likely to be used which preserves considerations of economic theory is total expenditure. This is, however, one further step away from measuring what one actually would like to measure; namely, nutritional status. Secondly, total expenditure is by definition relevant to some period of time, usually one year or one full agricultural production cycle. To obtain a measurement of total expenditure which would be useful in the strategy design phase, one would either have one calculated for the target population from a previous time period or one would borrow one from some non-target population from a previous time period. An important question is how appropriate would estimates of income based on non-target populations be for the target population. If this were the only available information, one could surely justify using it, although I would argue that information from the target group would be preferable.

Finally, in addition to the problem of sheer expense both in time and in money of collecting this information, the necessary information obtained may be replete with inaccuracies. These inaccuracies could be of two types: systematic inaccuracies and incidental inaccuracies. The systematic inaccuracies could be deliberately created by those being studied or by those suspicious about how the information might be used. Incidental inaccuracies could be the result of memory lapses and memory errors.

The subsistence potential ratio (SPR) variable which I will introduce is perhaps a better substitute for nutritional status than either income or total expenditure. The SPR is simply the ratio of the household's ability to feed itself to its need to feed itself. The household's ability to feed itself is determined by measuring the energy or protein value of the food which the household can produce over the course of the year, the agricultural production cycle, or the food consumption cycle.[4] The household's need to feed itself is measured as the energy or protein requirements of the entire household for the year, the agricultural production cycle, or the food consumption cycle.

This variable is attractive for the following reasons: 1) that it contains a measure of the productive potential of land, an essential component of income earning potential, 2) it would express this earning potential in terms of its capacity to meet satisfactory food and nutritional intake levels, 3) it would be easily, quickly, and cheaply obtainable for the target population, 4) its accuracy in certain respects would be greater than by using either the anthropometry approach, the dietary survey approach or the income-expenditure approach because the emphasis on memory is limited and its broaches no sensitive areas, e.g., income, skin folds, etc., 5) it would discern between those units of observation most likely to have some malnourished members or be at greater risk unlikely to have either malnourished household members or to be at nutritional risk, and 6) it would hopefully correlate with the primary food source(s) upon which the household depends for its food. This last point will be discussed in the following several paragraphs.

In light of the principal sources of food the household has for obtaining the food it consumes, one can examine the principal strategies which households follow to dispose of their production, namely to sell all, some, or none of their output. Changes in patterns of disposal caused by production improvements made in the farming systems can be viewed both as being dependent upon the food source mix and as causing cause changes in the food source mix. To the extent that increased agricultural output is either consumed on the farm, sold in the market, or partially consumed and partially sold, then the positive and negative nutrition consequences which occur will occur through changes in the level <u>and</u> relative importance of the food sources relied upon for consumption.

Therefore, an examination of the relative importance of the food sources relied upon for consumption at different SPR levels would be of value in determining what emphasis should be placed upon researching farming systems enterprises which are likely to result in increased consumption of home produced foods or increased consumption of market produced foods. It would then be possible to infer whether the production design of the FSR undertaking would place the nutritional status of households in jeopardy. Consider the following four alternative scenarios in Table 1: Scenario 1) in which both high and low SPR household consume primarily from home production, scenario 2) in which both high and low SPR households consume primarily from market sources, scenario 3) in which high SPR households consume primarily out of the home production, and scenario 4) in which high SPR households consume

---

[4]Modifications can be made to this one interpretation of a household's ability to feed itself. For instance, one could examine the energy or protein value of the food which the household is likely to produce for home consumption and purchase during the course of a normal year. Other interpretations are possible.

primarily out of home production and low SPR households consume food primarily obtained through market. Each of these settings, empirically verifiable, would then suggest the blend of research effort to be placed on enterprises primarily intended to result in the consumption of on-farm output and on enterprises intended primarily to result in the consumption of on-farm output through market channels. For example, I would hypothesize that emphasizing research into crops primarily intended for sale would result in a worsened nutritional situation for households in scenario 1), an improved nutritional situation in scenario 2), and an uncertain impact upon the nutritional situation of households in scenarios 3) and 4). If these hypotheses could not be rejected, then they provide some ex ante guidance to the appropriateness in a nutritional sense of FSR research emphases which are likely to stress increases in output for sale and/or increases in output for home consumption. The level of these changes of total output upon SPR and SPR upon total food consumption can also be studied.

Table 1. The Subsistence Potential Ratio and the Primary Source of Food Consumption Scenario

| Subsistence Potential Ratio | Primary Source of Food Consumption | Scenario 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| | High | H | M | M | H |
| | Low | H | M | H | M |

M = Food Consumed from Market
H = Food Consumed from Home Produced Source

The rationale for using the SPR in the strategy design phase of FSR projects would therefore be that it satisfied the four previously discussed criteria for the variable to be useful in the strategy design phase, namely, it distinguishes between groups of different nutritional status, it permits the examination of the nutrition benefit incidence to these different groups, it is based upon easily, quickly and cheaply obtainable information and finally, it has acceptable levels of accuracy. More detailed ex ante variables, such as the calorie consumption indicator suggested by Pinstrup-Anderson as a possibility, might provide extremely useful information in the strategy design phase; however, at apparent great expense.[5]

On-Going and Ex Post Analysis of the Nutritional Impacts of FSR

Although the major emphasis has been upon determining the likely effects of FSR activities upon food consumption before the FSR activities themselves get

[5]See Pinstrup-Anderson's brief discussion of the calorie consumption indicator (1981) pages 75-79.

underway, there are of course the actual effects of FSR activities upon food consumption and nutrition, which occur both during the period of the output-augmenting adoption and, finally, those which occur once the period of adoption [ends]. Perhaps the most important are those which occur as a result of the seasonal dimensions of cropping changes. This is particularly so when they impact upon the demand for labor and time allocation and, therefore, result in periods in which the household might be more or less liquid with respect to consumable food than it was prior to the advent of changes in the farming system. An examination to see whether or not there are periods in which food becomes relatively more scarce would be warranted, and particular attention paid to the intra-household food distribution process would undoubtedly provide valuable insights into the presumably important distributional impacts of changes in household food availability. Moreover, the normal cycle of the seasons itself imposes certain strains upon food consumption and nutrition levels. The synergism between disease incidence and low energy, food and nutrition levels on the wet season of the production cycle is particularly pronounced. Chambers, Longhurst, et. al., suggest in Table 1 a series of variables which could be used to monitor nutritional status in seasons likely to pose significant overall threats to general health and well-being, although variables which examine the synergism referred to above are lacking.

Performing some kind of ex post appraisal of the effect of FSR adoption on nutrition, once the adoption process is relatively complete, will likely be most useful as background information for other FSR undertakings. In this sense ex post analysis serves ex ante analysis. Meaningful ex post analysis requires a solid theoretical foundation such as that provided by the economic theory of the household. Renewed interest in this area has resulted in the development of household-firm models which re-emphasize the importance of consumption as a driving force behind production. These models have suggested new ways of examining the firm-household interrelationships which are of direct relevance to the study of farm behavior because of the interconnection between the farm as firm and the farm as a consuming household unit. A very practical offshoot of this theory is the recognition that data collected for each functional group should trace the production cycle (beginning with land preparation and clearing and ending with harvest as well as the consumption cycle beginning with harvest and ending with the period immediately prior to the following harvest).[6] Any useful analysis requires, therefore, that the data collection cycle be greater than for simply the production cycle, which would need to be augmented to represent more accurately the integrated production-consumption cycle of the household. Good food storage data, particularly beginning, ending, and other periodic inventories, along with records of changes which occur to household size due to labor migration, absence for schooling, death, etc., are also essential.

Income elasticities for calories by SPR, expenditure, or other nutritional status categories, should be calculated in order to examine the effect that food preferences and food quality considerations have on the functional categories of interest. These elasticities should also be calculated according to income source if one wishes to examine the hypothesis that the source of income, perhaps

---

[6]See Smith et. al. (pp. 69-73). In a discussion of methodological problems which result when data are not collected to cover both cycles.

a change in the wage earning of female household members, is an important influence upon food consumption and nutritional status. This would necessitate collecting information on income and/or expenditure during the full data collection cycle. The elasticity of calories with respect to the Subsistence Potential Ratio would also be interesting to examine and would provide an additional use of the SPR concept. The elasticity of demand for calories should also be calculated by functional category and should be based upon the prices for real goods, not a fictitious price of calories.

The extent to which FSR activities benefit large versus small farmers, through perhaps a possible FSR emphasis upon cash crop versus subsistence crop or sole versus mixed/multiple cropping technologies, and have significant long run effects upon nutritional status can only be answered ex post facto. There is no reason, however, why ex post findings such as these cannot be stated ex ante as plausible occurrences under certain circumstances. The primary value in incorporating nutritional considerations into FSR activities lies in insuring that the ex post findings as such do not evidence increased disparity in levels of nutritional well-being with higher levels of food poverty and concomitant malnutrition. The research emphasis among those of us concerned about using FSR as a vehicle to reduce intolerably high levels of malnutrition among the rural poor should therefore be upon advancing viable ex ante strategies which protect the nutritional interests of those likely to be affected by farming systems research throughout the world. If the incidence of malnutrition lessens due to more thoughtfully conceived FSR ventures, then this might lessen the need for the more costly ex post analysis. Whatever the case may be, a promising direction to follow requires researchers to develop and refine variables, such as the SPR, which are of direct usefulness in the planning stage and to use ex post analysis to help identify well conceived ex ante variables.

Table 2. Hypothesized Seasonal Variations.

| Factors | | Seasons | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Dry | | | Wet | | | Harvest |
| | | Early | Mid | Late | Early | Mid | Late | |
| Diseases | C-S Meningitis | | | - | | | | |
| | Malaria | | | | | | | |
| | Diarrhoea | | | | | - | - | - |
| | Guinea Worm | | | | | - | - | - |
| | Skin Infections | | | | | - | - | - |
| | Filariasis | - | | | | - | - | - |
| | Schistosomiasis | - | | | | | | |
| | Yaws | | | | | - | - | |
| Energy, food and Nutrition | Agricultural energy demand | (-) | + | | - | - | - | - |
| | " " Men | | + | | - | | (-) | - |
| | " " Women | (-) | + | | - | - | (-) | - |
| | Food stocks | + | + | | - | - | - | + |
| | Prices for food purchase | + | + | | | - | - | + |
| | Food Quality | + | + | | - | - | - | + |
| | Body weight/energy balance | + | + | | | - | - | -/+ |
| Economic | Debt and repayment factors | | | (-) | - | - | - | - |
| | Screws and ratchets | + | + | | - | - | - | (-) |
| Social and Demographic | Child care | + | + | | - | - | - | - |
| | Deaths | - | + | + | | - | - | - |
| | Neo-natal deaths as % of births | | | | | - | - | |
| | Conceptions | | H | H | | | | |
| | Births | | | | | | H | H |

Key:

+ = a positive, favourable, condition or effect
- = a negative, unfavourable, condition or effect
(-) = a less marked or less widespread negative, unfavourable condition or effect
H = High
Source: Chambers, Longhurst, et al., 1979, Appendix B.

## REFERENCES


Abalu, G. and D'Silva, B. 1979. "Socio-economic analysis of existing farming systems in Northern Nigeria.' Paper presented at the Workshop on Development of Semi-Arid Agriculture. ICRISAT, India, 19-23 February, 1979.

Chambers, R., Longhurst R., Bradley, D. and Feachem, R. 1979. "Seasonal Dimensions to Rural Poverty: Analysis and Practical Implications." Institute of Development Studies Discussion Paper No. 142. University of Sussex.Brighton, England.

Pinstrup-Andersen, P. 1981. "Nutrition Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches." World Bank Staff Working Paper No. 456. Washington, D.C.

Scrimshaw, N. 1977. "Through a Glass Darkly: Discerning the Practical Implications of Human Dietary Protein-Energy Interrelationships." W. O. Atwater Memorial Lecture. Nutrition review. Vol. 35, No. 12, pp. 321-337.

Smith, V., Lynch, S., Whelan, W., Strauss, J., and Baker, D. 1979. "Household Food Consumption in Rural Sierra Leone." Rural Development Working Paper No. 7. Department of Agricultural Economics, Michigan State University, East Lansing, Michigan.

Srinivasan, T. 1981. "Malnutrition: Some Measurement and Policy Issues." Journal of Development Economics. Vol. 8, pp. 3-19.

Streeten, P. 1979. "From Growth to Basic Needs." Finance and Development. Vol. 16, No.3, pp. 28-31.

Sukhatme, P. V. 1977. "Malnutrition and Poverty." Ninth Lal Bahadur Shastri Memorial Lecture.

Whelan, William. 1982. "Determinants of Food and Calorie Consumption for Far, Households in the North of Nigeria." Ph.D. Dissertation. Department of Agricultural Economics, Michigan State University.

# TRANSLATION OF STATION EXPERIMENTAL WORK TO FARMER'S FIELD

Michael D. Schulman
Department of Sociology and Anthropology
North Carolina State University
Raleigh, North Carolina

Traditional farming systems of small holders have evolved over time in response to the ecological, social and economic constraints in which farming families are involved. These complex systems of food and animal production represent reasonable and rational organizations of the existing physical and human resources (Harwood, 1979). If these traditional systems are to be modified so that they can become more productive (more efficient utilization of the given resources), and if new technology is to be the key method of improving productivity, then it is essential that agricultural scientists and technicians understand traditional farming systems before the introduction of new technology. Accordingly, upstream or baseline research is necessary in order to determine constraints and to identify the key problems for the agricultural research process (CGIAR, 1978).

Getting agricultural researchers and technicians to focus on the key problems facing small farmers is only a partial solution. The new technologies and innovations developed by researchers must be appropriate to the physical and socioeconomic constraints faced by small farmers. Therefore, downstream research for evaluating and monitoring the adoption of new technology and its short and long term consequences is also a necessary component (CGIAR, 1978).

The consequences of adopting appropriate technology by the farming household should be measurable in terms of increases in labor productivity, increases in family nutrition, and increases in the quantity or quality of food and fiber output. Improvements over time, especially in the quantity and the quality of agricultural production, and the adequacy of this production to household consumption needs, signal modification in what is socially and economically "appropriate" technology. Thus, the "downstream" monitoring of the consequences of technology transfer impacts the "upstream" development of "appropriate" technology.

The traditional model of agricultural research and development, once centered upon experiment station research, has often overlooked the downstream and upstream aspects of agricultural technology development, especially with reference to the farming systems of small holders. Work at experiment stations centers around agricultural scientists organized into disciplinary specialties or along commodity lines. The priorities for research are determined by the scientists themselves or by their parent organizations. There is little direct contact between scientists and their client populations. The technology developed through station research is assumed to be capable of generating increased yields and cash income for all types of producers. Extension organizations have passed the responsibility of diffusing the new technology to the early adaptors down into the laggards. When the diffusion or adoption of the new technology is incomplete, then social scientists are brought in to explain the problem in terms of the lack of "modernity" or "n-achievement" among the small farmers.

An alternative model for the role of experiment station research is based on the assumption that the development and transfer of new technology for small holders must be based on the actual needs of small holders (Gostyla and Whyte, 1980). Baseline data on agro-climatic zones and on the farming systems in the target area (from secondary sources or from field surveys) provide the initial starting point. On-farm studies and experiments directed by multidisciplinary teams are the next step. These studies involve analysis of the farmer as a technology user, analysis of the goals and aspirations of the farmer, and experimental trials of new technology with active participation of the farmer. Social scientists are intimately involved, not only in the analysis of the farming unit as a system, but in the analysis of how the individual farming unit fits into the wider systems of rural stratification. Information from the on-farm studies flow back to experiment station scientists, who focus their research on the design of components for improving the existing farming system, or on the design of new systems appropriate to the resource conditions (CGIAR, 1978). On-farm studies continue in terms of evaluating the responses of the farmers to the experiment station innovations. Farmers are actively involved in the evaluation process, and the results flow back to the experiment station researchers.

The differences between the traditional model of experiment station research and the alternative "farming systems" model center around the factors of information flow and participation. The alternative model proposes an active two-way flow of information between on-farm work and research at experiment stations and an active horizontal flow of information across scientific disciplines (Gostyla and Whyte, 1980). The alternative model also stresses the active participation of farmers themselves in defining needs, in trying new technological alternatives and in the evaluation of such alternatives. The emphasis on participation is consistent with recent research on small farm development projects, which found that project success was dependent upon a set of positive actions by small farmers including their participation in project decision making and their willingness to contribute resources to project work (Morss, et. al., 1975). If one accepts the alternative "farming systems" model as the norm, then the problem of translating experiment station work to farmer's fields becomes redefined as the problems of (1) getting experiment station research to focus on the needs of small farmers and (2) getting small farmers actively participating in the upstream/downstream process of research and technology development.

## REFERENCES


Consultative Group on International Agricultural Research. Technical Advisory Committee (CGIAR). 1978. Farming Systems Research at the International Agricultural Centers. Rome: FAO.

Gostyla, Lynn and William F. Whyte. 1980. ICTA in Guatemala: The Evolution of a New Model for Agricultural Research and Development. Ithaca: Cornell University, Rural Development Committee, Center for International Studies.

Harwood, Richard R. 1979. Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics. Boulder: Westview Press.

Morss, E. R., et. al. 1975. Strategies for Small Farmer Development: An Empirical Study of Rural Development Projects: Executive Summary. Washington, DC: Development Alternatives.

# LONG TERM VS. SHORT TERM CONSULTANCIES: ADVANTAGES AND DISADVANTAGES FROM AN AID MISSION VIEWPOINT

Myron Smith
BIFAD/S[1]

The viewpoints expressed by the author are based on a decade of experience in administering AID projects in the field in both the Asian and African regions with technical assistance support from U.S. Universities and the U.S.D.A. of various time durations. Results of both short and long term consultancies ranged from excellent to unsatisfactory. The factors contributing to this range of experience as perceived by the author and other AID personnel involved are described.

To enable all readers to have as uniform a concept as possible concerning the conditions that exist in providing economic development assistance to developing nations, and thereby to have a more realistic grasp of the role of professional consultants in this process today, several descriptive comments are provided at this introductory stage. Most of us in the U.S. are not well informed on the conditions of life in the rural villages in truly traditional rural societies in the LDCs. The issues involved in introducing the most elementary technology to tradition-engrained farmers in the villages of the LDCs are largely foreign to U.S. experience.

We in the U.S. are recognized by the LDCs as having superior agricultural technology, farmer production skills and agribusiness support as compared to other developed nations. The challenge is how to introduce this mix of production factors into the tradition oriented societies of the really least developed countries (RLDCS).

The technology of the 1980s can be introduced in the LDCs, but the introduction process requires recognition of the human, institutional, infrastructural, economic, and political factors existing in each country. Effective results can be obtained by expatriate, subject matter professionals if they have the patience and sincere interest to adapt technology to the absorptive capability of each nation. This skill must be acquired by experience and it is this process which is a major governing factor in whether consultants can produce useful results.

AID's experience with both academic and commercial consultants has been uneven. The unfavorable experiences were correlated to a large degree with attempts to transfer U.S. systems, which had evolved gradually to meet the specific U.S. conditions, to dissimilar socio-economic and ecological regimes. The selection of the principles to apply were incorrectly diagnosed by the U.S. professionals. Not until the concept of the Farming Systems approach evolved and was tested in the RLDCs has there been adequate recognition of the village level socio-economic conditions that are required to initiate improved productivity in the least developed communities of the LDCs.

## Factors Determining Choice of Long or Short Term Consultancies

The first determination of whether a consultancy will be of long or short term is made in accordance with the function to be performed. An illustrative

[1]USAID Direct Hire on detail to BIFAD/S.

list of functions, normally perceived to be best performed by each duration of consultancy, follows. This list is subdivided for those which are largely fixed by the function(s) and those where the choice could be optional.

1. Long Term Consultancies (Academic or Commercial)

   a. Duration Fixed (for multi-year projects)

      - Team leader of a technical assistance team of an institution building project (educational, research, extension, banking, ministry, directorate, etc. institutions).
      - Team leader of an economic development project (integrated area development, commodity production, irrigation systems, transport private enterprise, etc. projects).
      - Technical assistance specialists whose services, including both operations and planning, are continuous and non-seasonal (agricultural planners, statisticians, irrigation system designers and implementers, accountants, land use survey specialists, market development advisors, health advisors, veterinarians, water resource development specialists, etc.).

      Advantages Over Short Term Assignments

      - Closer and broader personal relationships are developed with host country and USAID Mission personnel.
      - There are greater opportunities and incentives to become acquainted with and to understand the socio-economic, political, cultural, and natural resources characteristics of the country of assignment.
      - There is greater opportunity to acquire fluency in the foreign languages of the host country where English is not the official language.
      - For private contracting firms, continuous assignments are almost essential as open market professionals rarely have assured employment opportunities during intervals between successive short term contract engagements.

      Disadvantages

      - For all procurement sources, the cost to AID per month of service is greater than for short term assistance as costs for shipment of household effects and personally owned vehicles, educational allowances, R&R travel, etc. must be provided from project funds.
      - For academic professionals, the two to four years overseas assignments continue to handicap professional advancements in their respective departments. In spite of efforts of some internationally sensitive academic administrators, there has not yet been a means developed to recognize overseas developmental experience with the same merit as experience on the campus.

   b. Duration Optional (for multi-year projects)

      Functions

      - Technical assistance specialist whose services, including both operations and planning, are not necessarily continuous and/or are seasonal.

(Entomologists, plant pathologists, agronomists etc., in single season cropping systems, curriculum designers, seed production technologists, crop storage advisers, etc.).

Description

Expatriate professionals for these categories of assignments could in some instances fulfill their principle assignments in about six months. If further continuity is desired at a lesser professionallevel than that of an assistant professor, U.S. graduate students could be hired under the project for a minimum of a calendar year to assist host country professionals to perform graduate student level skills, as well as to continue professional collaboration with counterparts in the implementation of the projects.

Advantages

- Cost per month of senior professional expatriates would be much lower. Further, fewer months service would be required for the life of the project than for long term professionals. Families could accompany the professional, but no sea freight nor shipment of personal vehicle would be authorized as the project could provide all of the household furnishings and equipment required through guesthouse/residence accommodations. Further, personal transport could be arranged on a reimbursement bases for distance traveled in project owned vehicle. No educational allowances nor R&R travel costs would be authorized.
- Academic professional personnel could continue teaching and conducting research functions at their universities for approximately six months each year. This could enhance the opportunity to attract a wider range of academic personnel for foreign development assistance.
- Graduate students would be exposed to foreign living and to AID operations in support of economic development and thereby a resource base of personnel experienced in economic development would accrue to the university and AID.
- Consecutive short term assignments by the same professional would provide the USAID and host country with personnel who know the host country and host country personnel important factors to achieve the performances expected.

Disadvantages

Many of these are the converse of the advantages for long term assignments, such as:

- Less incentive to learn and understand the socio-economic, political, cultural, and natural resources characteristics of the country of assignment.
- Less opportunity to acquire fluency in foreign languages where such are required in the country of assignment as compared to professionals on long term assignments.
- Less opportunity to attract quality professionals from non-academic contract sources that do not have off-season employment for the contract staff.

- Importantly also, the break in the presence in the LDC weakens the relationship fabric between the professional expatriate and the host country counterparts.

2. Short Term Assignments (several weeks to three months)

The functions for which these assignments are appropriate to AID's operations can be performed during short term assignments, are numerous, and include as examples: Project design and evaluation, special studies, short term training programs, technical assignments where short-term, specialized consultancy is required for specific project problems, and perform staff functions for USAIDs during intervals when agency recruitment is unable to fill critical vacancies.

Advantages

- Short term contract professionals can perform many functions for which AID direct hire staff do not have time and/or do not have the technical competence.
- Such professionals also are desired to infuse a fresh perspective to complement the in-country experience of AID direct hire staff who are susceptible to reduced breadth of vision as a result of their demanding operational problems.
- Higher quality professional academic staff are more readily available for short term assignments than for long term assignments.
- Experienced, retired AID employees and private consultants are available in larger numbers than for long term assignments.

Disadvantages

- Time is inadequate to observe and understand the socio-economic, political, cultural, and natural resource characteristics of individual countries--factors important singly or in multiples, depending upon the assignment, for optimum performance. (This handicap is reduced in accordance with the frequency a professional is engaged in consultant services with AID in the concerned geographic sub-region and in particular in the same country.)
- More AID direct hire time by both AID/W and USAIDs' staff is required per month of service for briefings and other support functions.

Factors Enhancing or Limiting Performance of Technical Assistance

The factors which enhance or limit performance of professional consultants result from four sources:

1. The contracting firm,

2. USAIDs (Mission staff and/or quality of project design),

3. Contract Team Members of Consultants,

4. Host Country counterparts.

These will be examined in order of their presentation for the various durations of assignments.

The Contracting Firm

a. Long Term Assignments

- Limiting Factors. The quality of professionals actually available for field assignments is frequently not the same as that proposed in the contract proposal. This occurs with both the private contracting firms and the universities. This has occurred even when selection of the contractor is made within one month of the due date of the proposals. Within the last nine months, a team leader who met personally with an AID/host country selection committee and assured them that he was available reversed his decision a week later. The contract had been awarded to the concerned firm during that week largely on the basis of the availability of the team leader. In another instance two deputy team leaders declined to serve on a very large project within 10 days after the private contracting firm which had nominated them was selected for that project. University proposals have also had large drop outs of proposed candidates on occasions for projects in remote locations. (Loss of proposed team members due to intervals of lengthy contract negotiations are understandable and are not included in the above illustrations.)
- University contractors are increasingly fielding outstanding professional staff. The quality of university teams on the whole is improving due to increased competition. The quality and performance of teams for contracts awarded prior to 1978 were occasionally below AID expectations. Unfortunately those earlier experiences are remembered as examples of university capability.
- The reluctance of Department Heads of Universities to authorize absence of highly qualified staff interested in overseas development and the failure to date on the part of most universities to recognize the merit of performance for advancement of staff members who accept foreign assignments continues to limit the average quality of university contract teams.
- Universities and private contractors have both failed to utilize AID training programs to brief contract team members and their spouses on issues involved in living overseas as well as to brief team members on the cross-cultural issues involved in implementing development projects with foreign nationals and of the particular development concerns of their client, AID. BIFAD has just recently contracted for design of orientation programs for both long and short term consultants. It is essential that team members, particularly contract team leaders, know the agency procedures exist for almost all operating situations that occur and must know what references are available on these regulations in the field.

b. Enhancing Factors

- The institutional linkages that develop between host country personnel and U.S. universities (and the USDA when it is the institutional contractor) has become an increasingly important factor over the years. Some universities have become increasingly aware of the value of their technical back-stopping resources as a unique advantage amongst technical assistance suppliers. The

superior performance of those relatively few U.S. universities has resulted in strong demand for their services. There is considerable opportunity for other universities to increase the quality of their performance.

c. Short Term Assignments (on multi-year projects)

Limiting factors (and in the converse, enhancing factors).

- When short term technical assistance is provided to support long term assigned staff, there is occasional failure on the part of the long term team leader to collaborate with the host country counterpart(s) to define specifically the objective of the assignment, to develop a tentative work plan, and to prepare all of the resources required in advance to optimize the effectiveness of the short term specialist. On occasions, from one fourth to one half of the short-termer's assignment is utilized in performing the above functions.
- Inadequate orientation is characteristic for short term assignments. The cost in reduced performance usually greatly exceeds the cost for adequate orientation training.

USAIDs

a. Long Term Assignments

Limiting factors (and in the converse, these are enhancing factors).

- Inadequate provision in the project for design and budget for responsible administrative and logistical support for high-level professional contract team members. High priced professional staff should not be utilized for logistical and administrative functions which can be performed by lower salaried personnel. Further, procurement of essential residential and operational supplies should be arranged sufficiently in advance so that supplies are available by the date of the teams' arrival.
- Inadequate recognition that language capability is a constraint that is resolved at lowest cost by authorizing language instructor costs to be financed by the project as well as time for training prior to reporting for duty when competent professionals are not readily available with the required language fluency. It is absolutely unrealistic to assume that subject matter specialists are available with competence in all languages required in adequate supply to meet all demands of donors for overseas assignments.
- Inadequate dialogue with host country counterparts to determine the most effective means to utilize professional technical assistance (under whatever in-country contracting mode is utilized) and inadequate monitoring of implementation performance to resolve jointly and promptly operational problems which arise. The AID project manager and if necessary the Mission Director must perform the role of referees and negotiators in disagreements.

b. Short Term Assignments (non multi-year projects)

- Inadequate determination of objectives and preparation of a tentative work plan prior to arrival of short term professionals.

- Occasional failure to provide a responsible foreign national to assist in arrangement of appointments, to be available to the short-termer(s) to provide supplementary background information to that provided by the USAID direct hire staff and to accompany the short-termer when such is cost effective.

Contract Team Members or Consultants

a. Long Term Assignments

Limiting Factors (again, in the converse these are enhancing factors)

- Inadequate sensitivity to AID's objectives in the project, to AID's operational regulations (some statutory), to AID's extensive experience with development strategies, and to their employee/client role.
- Inadequate effort to influence host country counterparts of obligation to meet target dates for project outputs, and where not possible, to develop revised work plans to achieve optimum performance.

b. Short Term Consultants (non multi-year projects)

Limiting factors

- More than occasionally limited experience of consultants in the LDC development milieu particularly on design and evaluation teams results in an end product that is not satisfactory.

Host Countries

a. Long Term Consultancies

- The major host country problem is the frequent inability to obtain optimum effectiveness from expatriate consultants on long-term assignments. There is human reluctance to acknowledge the need for advice. LDCs welcome financial assistance but generally (there are exceptions) prefer to exclude or reduce long-term technical assistance below the level AID considers appropriate. This element of human nature must be recognized.

  It is more the exception than the rule that long-term technical assistance teams have the skills in human relationships required to perform advisory services over several years in a manner that retains receptively on the part of counterparts. Where the exceptions occur, there is a strong and very experienced administrator as team leader. Maturity on the part of the host country counterpart supervisors, associated with acknowledgement on their part that professional skills of the host country staff are inadequate, are factors that enhance a productive relationship. The major initiative in obtaining and retaining host country receptivity, nevertheless, rests on the contract team leader and secondly upon the contracting firm to provide adequate support, including replacing low performing staff when necessary.

# COMPLEMENTARY ASPECTS OF RURAL ENERGY AND FARMING SYSTEMS

Richard Morse*
East-West Center Resource Systems Institute

Energy is integral to any farming system. Thus, the concept of complementary aspects of rural energy and farming systems alludes to interwoven elements of energy in farming systems. This subject is germane to work on Energy for Rural Development (ERD) being conducted cooperatively by the East-West Center Resource Systems Institute and institutions in seven Asian countries. Opportunities to collaborate with the University of Hawaii, College of Tropical Agriculture and Human Resources, have strengthened this experience. In examining and fostering energy components of rural development, we are finding farming system research concepts and methods very instructive. By accenting energy aspects here, I hope the mutual values of these cooperative research and educational efforts will be enhanced.

The farming system, in this context, is a relationship between social and organizational factors, including distribution of resources and benefits, and decisions and actions by men and women in rural families to choose, work with, and modify crop, animal, and forest production activities and technologies. Facets of this definition that emphasize energy and complement other definitions (e.g., Shaner, Philipp, Schmehl, 1982; Harwood, 1979) are listed next.

## Complementary Aspects

Landless Families. In five villages in north India studied intensively from an energy standpoint, landless families who work in agriculture constitute from 11 percent to 48 percent of village households (Agrawal, 1981). This range is reasonably characteristic of many developing Asian societies. These landless families' work is essential to farm operations. Their consumption of food and fuels derived from local resources is their principal means of survival--often at the lowest margin of survival or subsistence.

Other Occupational Groups. Artisan families who produce and repair farm and household implements, entrepreneurs and workers in rural industry, traders, teachers, and public employees also depend directly on the local farming system for food and fuels. The inputs and services these people provide to farm families, as well as those they consume, significantly influence local production and exchange activities involving crops, animals, and forest resources.

Women's Roles. Women are the principal users of rural fuels, since cooking accounts for about 60 percent of energy consumption in developing rural areas. Women also gather much of the biomass fuel used. Their time allocated to fuel-related tasks as well as to other stages of food preparation makes up a significant part of family time budgets. Effects on women from exposure to smoke during cooking tasks, although not yet understood, are potentially serious (Smith, Aggarwal, Dave 1982; Ramakrishna and Smith, 1982).

---

*Research on which this paper is supported in part by the United States Agency for International Development, Grant No. AID/ASIA-G-1393.

Biomass Fuel Use. Biomass fuels--fuelwood, animal dung, crop residues, natural vegetation--predominate in rural energy consumption in most developing countries. Competitive as well as complementary relations of biomass fuels with food and fiber crops significantly affect farm families' choices among production system alternatives.

Critical Limiting Factors. Energy necessary for land preparation, sowing, cultivation, irrigation pumping, agro-processing, and transport can inhibit farm output if it is (a) inadequate in quantity; (b) inappropriate in form or quality, requiring technical transformations for which current knowledge is inadequate; (c) not available on a timely basis; or (d) held by some families or groups but more acutely needed by others. In identifying critical limiting factors in a farming system, these specific aspects of energy must be assessed.

Opportunities for New Enterprise. Energy surplus and potential for new productive applications exist when (a) energy use is inefficient, through either management or technical factors; (b) little or no private or social cost is incurred to collect or process available energy resources; (c) energy is wasted; or (d) energy is used for purposes generally considered locally as unimportant. New information that stimulates new ways of thinking about these end-use, organizational, and allocative aspects can help local groups establish priorities and evaluate new resource and technology strategies.

Time and Work Allocations. Allocation of family labor time to the varied tasks linking fuel production with the crop-livestock-forest sphere is a crucial factor in assessing and developing local resources. The role and opportunity costs of men's and women's labor time, especially at peak seasons, are important but difficult factors to determine.

Valuing Animal, Biomass, and Land Resources. In many rural areas few formal markets exist where fuelwood, animal dung, crop residues, and natural vegetation are bought and sold. Evaluation of competing uses--such as dung for fuel or for manure--is difficult. Where non-monetized or partly monetized transactions predominate, new methods of ascribing value to animal and vegetable residues are needed in order to understand the optimal allocation of these resources and of the land and time used to produce or collect them.

## Development Research Goals

Human and physical resource transformations in rural areas are, I believe, founded in the values, motivations, needs, and constraints of rural people. The goal of development research is to strengthen people's ability to make these transformations. Knowledge held by rural residents is a primary resource for this purpose. Development research should help rural people (especially those with the most acute needs) learn how to build and adapt on their present knowledge to gain new initiatives in decision-making and new advantages in negotiating with outside groups.

In the energy-farming systems context, farm families and other community members need methods and information to:

1. improve their knowledge of food-fuel links and of new opportunities for greater productivity in crop, animal, and forest resources;

2. identify crucial factors that limit or block production increases and determine how to overcome them;

3. invent new ways of organizing and allotting work activities, to add value and share benefits more equitably;

4. evaluate alternative energy technologies, both by contributing to their design and by operating, testing, and modifying them to fit particular daily and seasonal conditions; and

5. realize economies of scale and of transactions in food and energy resources, through appropriate group and community organization.

Knowledge Advantages of Rural Citizens

Social and farming conditions that determine energy uses and sources vary considerably. Studies to discover regularities are rare. The specific knowledge that producers and users of rural energy have about existing amounts, forms, and attributes of locally available energy is a basis for assessment of potential changes. In a mutual learning process, the researcher raises new questions and adds new information. In such local planning, a key question is: what information from outside is relevant and needed to add to local knowledge, to build an adequate picture?

Particular groups of rural residents have special insight into various types of information, as illustrated.

| Knowledge holders and generators (women, men, families) | Types of knowledge and advantages (daily, seasonal, annual) |
|---|---|
| Landless families<br>Farm laborers | Collected fuels: wood species, parts, attributes; animal dung; crop residues. Forage and grazing areas; depletion. Collection times, distances. |
| Artisans: smith, carpenter, potter, weaver, woodsman, leather-worker<br>Service: midwife, tailor, | Alternative earning opportunities variability, risks, trade barriers and inequities, wage negotiating factors. |
| Marginal and subsistence farm families | Inferior grains and fuels: residue uses and substitution; animal maintenance and services; food and fuel uncertainties; coping strategies. |
| Small-scale and medium-scale farm families | Crop rotation; irrigation; animal power; fodder; storage; dairying; market variations; cash management; diesel and kerosene; electricity connections. |
| Large-scale farm families, landlords | Cash crop specialization; fuel purchases; tree and grove management; labor trends, work organization; mechanization; lubricants, gasoline; marketing; supplier and bank credit. |
| Agro-processors, traders | Stocks; storage facilities, truck and rail transport; crop futures, margins; |

| | |
|---|---|
| | fuel-wood marketing; machinery supply, repair and maintenance. |
| Village and district officials | Selective data on above; range and approximate distributions; secondary data. |

Most of this primary information is in local terms and units of measure. Many of these terms pertain to barter and in-kind transactions not reflected fully in the price economy. Estimating the magnitude of this unpriced zone and its terms of exchange requires close familiarity with local knowledge generators.

Need and Scarcity Assessment

Need is a commonly used and understood word but difficult to define precisely. People do know their own direct needs best. However, they may not comprehend the conditions influencing their needs; they may not be able to assign values to those conditions.

How people adjust or mitigate their situation when they lack energy resources indicates need. In certain seasons in Bangladesh, some rural families are not able to obtain fuel to cook more than once a day. They dig up roots from dead trees, or cut excess amounts of live wood from common forest land (Islam, 1980). These acts have contributed to soil erosion and loss. If families are forced to trespass on others' land and trees to obtain fuel, how is this to be measured in terms of need?

In Java, the poorest families consume less fuel because they consume less food. This is clear evidence of a suppressed need for both food and fuel. They find enough energy to cook the food they have (Islam, Morse, Soesastro, eds., 1983). In some villages, minimum fuel needs are met by sharing among households; well-to-do families often let other families collect branches and twigs from their land.

Scarcity takes many forms. Seasonality is often a major factor. Identifying and evaluating resource scarcity is an important step both in assessing local factors that limit increased productivity and in allocating resources among different areas according to where and how far scarce inputs curtail development or prevent attainment of basic needs.

Enhancing Energy Efficiency and Conserving Environmental Resources

In many rural areas, some families who are not assured of obtaining sufficient food and fuel for daily needs are forced to use their resources less efficiently than available technology permits. Use of general-purpose stoves that accommodate inferior biomass fuels as well as high-quality fuelwood is an example. Design needs of actual users must be the basis for stove improvement programs, but at the same time better fuelwood supply should be assured for greater efficiency. Peoples' valuations of these options as well as social measures to assure against their risks are essential components for such conserving steps.

When women are engaged in farm operations, such as during peak sowing, weeding, and harvesting seasons, efficient use of time for cooking activities

may be more critical than efficient use of fuel. To save cooking time, they use more fuel (Islam, 1980). These situations illustrate how energy efficiency differs among ecosystems and farming systems. Differences in forms and efficiency of energy use have cause and effect relationships with availability and scarcity of physical resources, landholding structures, farming practices, and task and time allocations among women, men, and children.

Local Initiatives and Interactions for Energy Technology Assessment and Development

Valid field assessment methods for animal and biomass resources must incorporate judgements of the farm and labor families who produce, transport, and consume these materials, and the recommendations of specialists about local resources and their valuations in alternative uses. More fundamentally, people's active involvement in assessing new technologies and methods of resource organization, using their own knowledge together with that of specialists, is a key to success in their choosing viable practices. Action research and participant research are essential methods for achieving this involvement.

Our most promising lessons in this regard are based on Dr. Deepak Bajracharya's work as a facilitator in need, resource, and technology assessments by three communities of Chgoprak Village Panchayat, Nepal, from February to July 1982 (Bajracharya, 1982; Islam et al, 1983).* While residing in the area, he assisted communities at low altitudes (500-700 m), mid-altitudes (800-1,000 m), and high altitudes (1,400-1,600 m) -- each populated by different castes -- in their assessment of priorities and viability of alternative energy systems. The low altitude wards decided upon, negotiated, and installed two community-scale biogas digesters ($20m^3$ ) to power grain grinding and oil expeller machinery. Some 140 households at mid-altitudes installed improved stoves. The third community did not reach agreement. Bajracharya examines the social and technical factors in these differential responses. He observes: "Considering that all problems cannot be solved at once, the people in the rural community interact among themselves to determine their own priority and express the need for the new technology" (in Islam et al ).

This experience manifests four key principles:

1. User participation in actively assessing priorities, needs, and new resource combinations is a critical ingredient to implementing and sustaining new energy technologies.

2. In interaction with a skilled facilitator, communities can innovate and adapt their existing institutions to provide for fair sharing of new opportunities; in the biogas case, 65 families were able to agree on differentially structured resource commitments and obligations, with fair distribution of benefits.

---

*Dr. Bajracharya carried out this project through a cooperative agreement between the East-West Resource System Institute and the Resource Conservation and Utilization Project, Nepal.

3. Individual and group capacities to manage and operate new systems can be rapidly developed by experiential learning and well-focused training.

4. Many such accomplishments are possible in other rural areas through continued action research that contributes to curriculum development and experiential training of facilitators and local researchers.

## Local Systems Assessment: Evidence of Scarcity and Potential

### The Cooking Sector

Energy needed for the cooking sector provides a thematic perspective to interpreting food-fuel links in farming systems. These links influence the adequacy of food to meet basic nutrition needs. One observed response to fuel scarcity, as already noted, is to reduce the number of hot meals per day, increase consumption of uncooked food, and heat tea or coffee water to below the boiling point. The health implications of these adjustments are not fully understood, but incidences of food related diseases could increase. Less protein and sometimes fewer calories with certain uncooked or partly cooked foods may also result in lower nutritional value (Foster, in Islam et al).

The implications of these responses to fuel shortages appear to be more severe for particular groups, including small landholders and landless families. Nutritional surveys show these groups are especially prone to deficient diets in terms of calories, protein, and vitamins (Institute of Nutrition and Food Science, Dacca, 1977). Energy micro studies show these same groups often have limited access to biomass resources to use in cooking their food. Thus any reductions in availability of food or fuel affect these groups' nutrition more severely.

What are the fuel requirements of a family with a certain number of members for cooking food for one day at current levels of food and fuel consumption? At improved levels of nutrition (meeting the local minimum daily requirement), what is the per capita increment of fuel that would be required? This relation between fuel needs and food needs must be understood if adequate and sustainable quantities of food and fuel are to be produced from a given land base. Fuel links to nutrition, then, have important implications for the food policy planner as well as for the village researcher and development specialist concerned with either food or energy (Foster, ibid).

### Contrasts in North India Villages

Profiles of domestic fuels consumption in five Uttar Pradesh Villages demonstrate the location-specific, heterogeneous nature of rural energy systems (Table 1). Two of the villages, Naraich and Pindari, are the Trans Jamuna agro-climatic zone characterized as "alluvial veneer," with hill outcroppings and ravines. Dung cakes and crop residues dominate their high cooking-fuel use. The remaining three villages, all in the alluvial Ganga-Ghagara agro-climatic zone, have distinctly different patterns of fuel use (Agrawal, 1981).

Village-scale indicators are used to analyze connections between these fuel use profiles and the local farming system (see Table 2). Unfortunately, separate indicators for each land holding and income group are not available. However, indicators shown in Table 2 reveal different combinations of farming and fuel resources for each village, even those within the same agro-climatic zone.

The amount of the various biomass resources available in the village greatly influences the fuel mix. Nariach and Pindari villages, located in an agro-climatic zone characterized by extensive farming, have more land, cultivated area, and animals per person than the other three intensively-farmed villages in the Ganga-Ghagara zone. This resource factor accounts for high dung cake and crop residue use in the first two villages.

Scarcity of fuelwood is shown by resource indicators for Hariharpur, even though wood provides 38 percent of per capita cooking fuel consumption. The weak fuelwood supply position is evident from the number of trees owned per family (1.2) and per hectare (0.4). To identify the nature of pressure on fuelwood and other resources, however, distributive and geographic aspects of landholding and use must be examined.

Land distribution in Hariharpur is highly unequal. Sixty percent of farm families hold 19 percent of the land in holdings of less than 2 hectares. Thirteen percent of the farmers hold 50 percent of land in holdings of 5 hectares and larger. Landless labor makes up 48 percent of the occupational distribution.

Shifting stream beds inhibit sustained land management in sections of the village land. Low cropping intensity (index .99 in Table 2) and a small irrigated area (38 percent) are resulting features. High wheat and paddy yields are evidently associated with high fertilizer and manure use on cropped land, but the low cropping intensity and relatively small number of families in agriculture in Hariharpur (only 34 percent) result in very low grain output per person per year (133 kg) and a correspondingly low share of grain marketed (11 percent).

The high numbers of cattle in Hariharpur per farm family (5.1) and per landless family (2.4) are more equally distributed than land, however. Landless families own about 34 percent and small-scale farmers 30 percent of the bovine animals. High annual fodder consumption per bovine animal (3,900 kg), dung recovery per animal (2,100 kg), and dung recovery per person (690 kg) sustain the role of dung cake as the most used cooking fuel in Hariharpur (50 percent). Relatively high application of manure per gross cropped hectare (1,980 kg) suggests how intensely marginal and small-scale farmers use this resource.

The shares of dung cake consumed as fuel by poor and very poor families, however, are far less than their shares of animals. Shares consumed by upper income families exceed their share of animals. The high 24 percent of dung cakes purchases is evidence of substantial dung cake sales by landless families to upper income families. Collection of fuelwood from non-owned sources is common (28 percent) and evidently helps small farmers retain significant amounts of dung for use as manure.

These indicated actions by different resource holders in Hariharpur offer a basis for re-examining the fuelwood situation. Fuelwood's substantial share in fuel consumer by upper income groups, its high market price (Rs. 22 per 100 kg), and the high percentage of families purchasing fuelwood (19 percent) indicate demand pressure on this limited resource. One scarcity indicator, the 2.4:1 fuelwood/dung cake price ratio, is far above the 1.6:1 approximate energy equivalent value of 1 kg of fuelwood compared to 1 kg of dung cake. Not only is wood as a fuel extremely scarce, but also these figures may reflect preference of upper income groups for fuelwood, which reinforces its overall scarcity.

This diagnosis has these implications:

1. Afforestation is sorely needed. An assessment is recommended of possible use of underutilized and flood-prone land. An interdisciplinary team made up of forest, soil, water management, and animal husbandry specialists should work with the community to find out if such land could be utilized successfully.

2. This assessment would need to determine whether such land is currently used for grazing the large number of animals held by landless and small farm families. If so, new institutional arrangements would be needed to select and manage species suited to these lands to increase both fodder and fuelwood production.

3. Hariharpur agriculturalists, especially those with small holdings, place high value on the use of dung as manure. Therefore, dung might be replaced as fuel by appropriately sized biogas systems with the residual slurry being used as manure.

4. Assessment of new means of organizing energy technologies must take into account the large family size (12 to 16 members) of upper income groups in Hariharpur. Like other groups, this segment of the population evidently needs resource and employment development opportunities, but in activities that reduce, not widen, existing segmented structures in the village.

In Hazipur, no large landholding families were reported. Low energy consumption in Hazipur is associated with an extremely limited land resource base (Agrawal, 1981). Landless workers make up 34 percent of sampled families. Marginal holdings account for 49 percent of agricultural land, small holdings the rest. Animal distribution, however, is less unequal than land distribution. Laborers and farmers with fewer than two hectares hold 67 percent of animals, on 49 percent of farm land. Dung cake consumption for fuel by these families, about 45 percent of the total, is substantially less than their share of animals. An interesting pattern emerges. To gain cash income, 32 percent of the dung produced is sold for compost and 11 percent for dung cakes. Natural vegetation (green plants) accounts for 29 percent of total fuel consumption. At this low level of fuel use, natural vegetation takes on an implicitly positive value, equivalent to the cash value of dung which it replaces as fuel, less the difference in whatever value is ascribed to collection times for these two biomass materials.

Valuing Animal, Biomass, and Land Resources

In several of the villages described, cattle are held more equitably than land. In those cases, as V.S. Vyas has observed, distribution of a mobile farm resource (livestock) tends to be more equal than that of land. Mobile resources apparently offer development opportunities that warrant special attention. Thus energy input and output characteristics of livestock are particularly important.

A forthcoming technical paper by one of the Energy for Rural Development team addresses the problems of identifying and controlling the factors that form a basis for valuing dung used as manure (Foster, 1983). In this analysis, the average physical product of manure is the proxy measure that appears most relevant

to the farmer's actual situation.* From experiments conducted over a 13-year period in West Bengal, India, where rice was grown on laterite sandy-loam alkalite soils, a proxy value for manure of approximately Rs. 20 per 100kg (1980 prices) was estimated at an application rate of 6,500 kg/ha. This value cannot be strictly compared to manure prices cited in Table 2 because (a) the effect of soil and rice varietal differences cannot be ascertained and (b) the experimental manure application rate was more than three times the average of the village (Hariharpur) with the highest average manure use per hectare. Nevertheless, the proxy value of twice the market price of the limited proportion of manure purchased indicates strongly that this basic resource is being undervalued. On-farm research, while difficult to organize, appears essential to obtain a more reliable set of values for dung in its alternative uses.

Estimation and valuation of crop residues in their competing uses as fodder, fuel, pulp, and building material are also very area-specific. Energy values for a variety of these materials were obtained in a Thailand study (Arnold and deLucia, 1982). Assigning proxy values was not attempted, however. Zero opportunity costs for crop residues have been assumed in a number of studies to illustrate methods of resource and project appraisal (Halse, 1979; Meta Systems, 1980). Only if these residues are found to be indeed surplus in a particular area or community, can the feasibility of their proposed fodder or energy use be assumed.

Energy densities of biomass fuels are low, though varying, so proximity to supply is important. Transport cost is high compared to energy value. Availability and allocation of the work time of family members to collect these fuels can limit their use. Values placed by family members on work time are part of the value built into forms and quantities of biomass, whether collected for their own use of exchanged through the price mechanism. Perceptions of value lead to the question, "In a particular place and particular season, which fuel or biomass resource sets the opportunity cost against which a new or substitute fuel or technology must compete to be viable?"

Rural Energy Systems Research and Development

These brief examples show that rural energy systems assessment, planning, and development is a young art, especially compared with Farming Systems Research and Development (FSR&D). Yet both have the same characteristics: farm family based, problem solving, comprehensive, interdisciplinary, complementary, interactive, dynamic, and responsible to society (Shaner et al). In addition, rural energy assessment and organization are community based and situational.

The criterion of acceptance by the whole farm family as the key measure of success in FSR&D (Shaner et al) applies also in rural energy systems research and development, but the need for and success of energy systems often arise at the scale of the neighborhood or entire village. The community group or entity

---

* Value of marginal physical product is the relevant measure for a farmer's decision, but marginal data for the relevant rates of manure application are not available. Average physical product of manure is estimated from those few crop experiments that have been conducted over several years, comparing crop outputs on plots with specified applications of manure to control plots without manure. Then the difference in crop yield is valued at market price.

is therefore a principal base of local energy planning research. Landless and marginal farm families, especially, are important constituents of rural energy research and organization.

The community is viewed as a starting base for research and planning, not as a limiting boundary (Vayda, Colfer, and Brotokusumo, 1980). Rural energy systems research and development starts on the farm, in the farm household, and in the community and reaches out laterally, influenced by agroclimatic, scale, and social factors and opportunities pertinent to the concerned energy end uses, sources, and forms. It is multi-centered or poly-centered, and extensive.

As a young art, we should not claim too many attributes. But the learning experience in Chgoprak suggests that rural energy assessment and organization may aspire to (1) insure risk, (2) reduce uncertainty, and (3) articulate policy.

First, research within each ecosystem tries to identify those variations in biological productivity, such as those associated with site factors and yields of improved fuel wood species, that can be assigned some known probability over a meaningful planning horizon. By identifying a range of probabilities for important classes of risk, a basis can be acquired for local invention of institutional arrangements to lessen the adverse impacts of risk.

Then, creativity as well as stress can grow out of ambiguous and potentially discordant situations. One characteristic inherent in social behavior is the ability to guard against how other parties may react to prospective changes in resource access or distribution. This area has been termed "strategic uncertainty" (Bromley, 1982). Local energy planning research seeks paths or organizational development drawing together new opportunities for increased productivity and energy efficiency, resulting in new value added. It fosters plus-sum, "win-win" avenues of development and thereby has the potential of reducing anxieties derived from strategic uncertainty.

This emerging art of rural energy assessment and organization also may aspire to articulate policies. In local planning situations, communities are originators of new policies. Local policy innovations reach out spatially over nearby environments, but then may be blocked or distorted by tax, price, or resource allocation policies set at regional or national centers. Researchers working in local, situational modes can help translate local policy initiatives and organizing features to persons responsible for policy planning in state and national agencies. This process builds on the complementary aspects of Farming Systems Research Development. Constituents in different sectors and regions, having different needs and planning horizons, can then articulate policies that add up to new, poly-centered social responsibility.

TABLE 1

PATTERNS OF DOMESTIC ENERGY CONUMPTION, BY FUEL TYPE, FIVE UTTAR PRADESH VILLAGES

| Village | Population (sample) | Domestic Energy Consumption per person, monthly (Kcal. x$10^3$) | Consumption by Type of Fuel (Percentage Kcal.) | | | | |
|---|---|---|---|---|---|---|---|
| | | | Dungcakes | Crop residues | Firewood | Spring plants | Leaves and Twigs |
| Pattern 1: Dungcakes, Crop Residues | | | | | | | |
| Naraich | 289 | 267 | 46 | 29 | 19 | 6 | 1 |
| Pindari | 863 | 174 | 56 | 35 | 1 | 7 | 0 |
| Pattern 2: Firewood, Dungcakes | | | | | | | |
| Patharhat | 1,394 | 166 | 26 | 3 | 57 | 10 | 3 |
| Pattern 3: Dungcakes, Firewood | | | | | | | |
| Hariharpur | 648 | 165 | 50 | 8 | 38 | 3 | 0 |
| Pattern 4: Dungcakes, Spring Plants, Firewood | | | | | | | |
| Hazipur | 332 | 113 | 49 | 0 | 22 | 25 | 4 |

Source: Agrawal (1981).

Table 2
VILLAGE FARMING SYSTEM AND DOMESTIC FUEL CONSUMPTION INDICATORS, FIVE UTTAR PRADESH VILLAGES

| Village | Population (sample) | Population below Rs. 2,400 annual family income (%) | Share of farm assets, families below 2 ha. Land ( %) | Share of farm assets, families below 2 ha. Animals ( %) | Cooking fuel consumption per person ($10^3$ kcal/mo) | Gross cropped area per person (ha) | Irrigated to gross cropped area (%) | Multiple cropping index | Grain production per person (kg/yr) | Crop residue output per person (kg/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| Profile 1: Dungcakes, Crop Residues | | | | | | | | | | |
| Naraich | 289 | 22 | 8 | 32 | 267 | .48 | 30 | 1.04 | 516 | 546 |
| Pindari | 863 | 21 | 12 | 31 | 174 | .38 | 65 | 1.08 | 356 | 413 |
| Profile 2: Firewood, Dungcakes | | | | | | | | | | |
| Patharhat | 1,394 | 27 | 41 | 71 | 166 | .20 | 100 | 1.64 | 263 | 170 |
| Profile 3: Dungcakes, Firewood | | | | | | | | | | |
| Hariharpur | 648 | 32 | 19 | 64 | 165 | .15 | 38 | .99 | 133 | 158 |
| Profile 4: Dungcakes, Spring plants, Firewood | | | | | | | | | | |
| Hazipur | 332 | 40 | 49 | 67 | 113 | .17 | 93 | 1.79 | 241 | 218 |

Cattle and Dung Subsystem

| Village | Dungcake fuel use per person ($10^3$ kcal/mo) | Grazing area per bovine animal (ha) | Cattle per person (No.) | Buffaloes in total livestock (%) | Fodder consumption per bovine (100 kg/yr.) | Milk output per buffalo (kg/yr) | Dung Recovery per animal (100 kg/yr.) | Dung Recovery per person (100 kg/yr.) | Share of Dung Used as: Manure (%) | Share of Dung Used as: Fuel (%) | Manure per gross cropped hectare (100 kg/yr.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Profile 1: Dungcakes, Crop Residues | | | | | | | | | | | |
| Naraich | 122 | .51 | .53 | 21.2 | 14.4 | 208 | 10.0 | 5.3 | 24 | 75 | 2.8 |
| Pindari | 98 | .70 | .31 | 20.2 | 20.8 | 218 | 16.9 | 5.2 | 29 | 71 | 4.0 |
| Profile 2: Firewood, Dungcakes | | | | | | | | | | | |
| Patharhat | 43 | .02 | .22 | 17.8 | 32.8 | 865 | 17.5 | 3.9 | 56 | 43 | 10.8 |
| Profile 3: Dungcakes, Firewood | | | | | | | | | | | |
| Hariharpur | 83 | .07 | .33 | 22.7 | 39.0 | 1,060 | 21.0 | 6.9 | 42 | 40[1] | 19.8 |
| Profile 4: Dungcakes, Sprin;g plants, Firewood | | | | | | | | | | | |
| Hazipur | 56 | 0 | .34 | 30.0 | 44.8 | 1,465 | 23.3 | 7.9 | 29 | 28[2] | 13.4 |

[1]Nine percent used in biogas plant, 7 percent sold as compost, 2 percent sold as dungcake.
[2]Thirty-two percent sold as compost, 11 percent sold as dungcake.

Table 2 (Continued)

| Village | Fuel Consumption Per Person | | Fuelwood Subsystem | | | Monetized Exchange Subsystem | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crop residues ($10^3$ kcal/mo) | Spring plants ($10^3$ kcal/mo) | Fuelwood consumption per person $10^3$ kcal/mo) | Trees Owned per farm family (No.) | Trees Owned per hectare (No.) | Percentage of production marketed Grain (%) | Percentage of production marketed Milk (%) | Dungcakes purchased (%) | Families purchasing fuelwood (%) | Price Ratios dungcake/ manure ($P_d/P_m$) | Price Ratios fuelwood/ dungcake ($P_f/P_d$) |
| Profile 1: Dungcakes, Crop Residues | | | | | | | | | | | |
| Naraich | 78 | 16 | 48 | 2.5 | .5 | 42 | 0 | 17 | 3 | 1.33 | 1.69 |
| Pindari | 61 | 12 | 2 | 1.8 | .4 | 39 | 45 | 3 | 0 | 1.50 | 1.79 |
| Profile 2: Firewood, Dungcakes | | | | | | | | | | | |
| Patharhat | 6 | 17 | 96 | 4.9 | 4.4 | 26 | 58 | 7 | 3 | 1.25 | 2.00 |
| Profile 3: Dungcakes, Firewood | | | | | | | | | | | |
| Hariharpur | 14 | 4 | 63 | 1.2 | .4 | 11 | 52 | 4 | 19 | 1.29 | 2.44 |
| Profile 4: Dungcakes, Spring plants, Firewood | | | | | | | | | | | |
| Hazipur | 0 | 29 | 24 | 5.4 | 4.0 | 19 | 75 | 18 | 2 | 1.10 | 2.00 |

Source: ERD based on Agrawal (1981).
Note: At assumed efficiencies, technical rate of substitution fuelwood for dung = 1.64

## REFERENCES


Agrawal, S.C. Rural Energy Systems in Two Regions of Uttar Pradesh; First Phase Report. Honolulu, Hawaii: East-West Resource Systems Institute, 1981. 180 pp.

Arnold, John and deLucia, Russell J. Rural Energy Surveys: The Thailand Experience. Meta Systems, Inc., 1982.

Bajracharya, Deepak. "Experiences as a Lami: Energy for Rural Enhancement in Gorkha." The Rising Nepal. Kathmandu, Nepal: Gorkhapatra Corp., 1982.

Bromley, Daniel W. "Economic Issues in Forestry as a Development Program." Asia Society Conference paper, 1982.

Foster, Elizabeth. In Rural Energy to Meet Development Needs: Issues and Methods (Chapter 12). M. Nurul Islam, Richard Morse, and Hadi Soesastro, eds. Honolulu, Hawaii: East-West Resource Systems Institute, (forth-coming, 1983).

Foster, Elizabeth. Proxy Valuation of Dung. Honolulu, Hawaii: East-West Resource Systems Institute, (forthcoming, 1983).

Harwood, Richard R. Small Farm Development: Understanding and Improving Farming Systems in the Humid Tropics. Boulder, Colorado: Westview Press, 1979.

Halse, Michael. "Producing an Adequate National Diet in India: Issues Relating to Conversion Efficiency and Dairying." Agricultural Systems 4(4):239-278, 1979.

Institute of Nutrition and Food Science, University of Dacca. Nutrition Survey of Rural Bangladesh, 1975-76. Dacca, Bangladesh, 1977.

Islam, M.Nurul. "Study of the Problems and Prospects of Biogas Technology as a Mechanism for Rural Development: Study in a Pilot Area of Bangladesh (Village Resources Survey for the Assessment of Alternative Energy Technology)." Dacca, Bangladesh: Bangladesh University of Engineering and Technology, (Draft, 1980), 135 pp. and appendices.

Islam, M. Nurul, Morse, Richard, and Soesastro, Hadi, eds. Rural Energy to Meet Development Needs: Issues and Methods. Honolulu, Hawaii: East-West Resource Systems Institute, (forthcoming, 1983).

Meta Systems, Inc. State-of-the-Art Review of Economic Evaluation of Non-Conventional Energy Alternatives. U.S. Department of Agriculture Forest Service, 1980.

Ramakrishna, Jamuna and Smith, Kirk R. "Smoke From Cooking Fires: A Case for Participation of Rural Women in Development Planning." Honolulu, Hawaii: East-West Resource Systems Institute, (Working Paper, 1982).

Shaner, W.W., Philipp, P.F. and Schmehl, W.R. Farming Systems Research and Development: Guidelines for Developing Countries. Westview Press, 1982.

Smith, Kirk R., Aggarwal, A.L. and Dave, R.M. Air Pollution and Rural Fuels: A Pilot Village Study in India. Honolulu, Hawaii: East-West Resource Systems Institute, 1982.

Vayda, A.P., Colfer, Carol J. Pierce and Brotokusumo, Mahamad. "Interactions Between People and Forests in East Kalimantan." Impact of Science in Society, Vol. 30, No. 3, 1980.

Vyas, V.S. "Structural Changes in South Asia Agriculture: Implications for Food Grains Production." Outline of a Research Proposal. Ahmedabad, India: Indian Institute of Management, 1981.

## SYMPOSIUM PARTICIPANTS

DUANE ACKER is President of Kansas State University (KSU). He has been Vice Chancellor of Agriculture and Natural Resources at the University of Nebraska-Lincoln; Dean of the College of Agriculture and Biological Sciences, Director of the Agricultural Experiment Station, and Director of the Cooperative Extension Service at South Dakota State University. He is a fellow of the AAAS. He was named by the National Academy of Sciences as one of 12 U.S. representatives at the International Scientific Forum held in Hamburg, West Germany. Acker has traveled extensively in South America, China, Nigeria, and the Philippines.

JOCELYNE ALBERT is an Agricultural Economist with the Program and Policy Coordination/Office of Women in Development at the U.S. Agency for International Development, where she reviews projects and evaluates proposals. She was involved in country programming, design, and evaluation of development projects for the Regional Economic Development Services Office/West Africa during 1979-82. Albert also worked as a secondary school teacher in the Ivory Coast (1978-79) and as an intern at the American Embassy in Senegal (1978).

JOSE ROMAN ARAUZ is Coordinator of the Regional Agricultural Research Program in Panama. During 1975-80, he was Auxiliary Professor in Fertility and Analysis of Soils at the Regional University Center at Chiriqui, Panama. In 1967-70 he was in charge of the Regional Agronomy Program in Chiriqui. Arauz was the Panama counterpart for the Rural Land Program and Chief of the Soils Laboratory in the Ministry of Agriculture and Livestock (1964-66).

NANCY AXINN is a Women in Development Specialist for the Bean/Cowpea Collaborative Research Support Program (CRSP) at Michigan State University. Her work on the CRSP involves twelve countries in Africa and South America and fifteen U.S. university institutions. She has been involved in consultancies in Jamaica, Nepal, Malawi, Botswana, and Swaziland. Axinn is coauthor of the book "Continuity and Change in the Rural Social Systems of Nepal: An Energy and Social Differentiation Approach to Farming Systems."

RICHARD BERNSTEN is an Agricultural Economist at Winrock International Livestock Center, Morrilton, Arkansas. As an Associate Economist in the International Rice Research Institute's (IRRI) Indonesian Outreach Program (1978-81), he provided technical direction to the Socioeconomics Department of the Central Research Institute for Food Crops. He was also a Peace Corps Volunteer in Sierra Leone, West Africa (1967-70), where he served as village extension agent in rice, corn, poultry, and pig production. Bernsten has made short-term visits to Malaysia, the Philippines, Thailand, Nepal, China, India, Liberia, Ivory Coast, Ghana, and Upper Volta.

CHARLES BUSSING is an Assistant Professor of Geography at Kansas State University (KSU) and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. He traveled to Latin America in 1980 to study the conditions of small-scale farmers in Guatemala, Costa Rica, and Mexico. Bussing was also a member of the KSU team that carried out the recommendation domain study in 1981 for the Botswana Agricultural Technology Improvement Project.

CAROL PIERCE COLFER is a Farming Systems Specialist on the Tropsoils Project at the Hawaii Institute of Tropical Agriculture and Human Resources (HITAHR), Honolulu, where she is responsible for providing the social science component of a Soil Management Collaborative Research Support Program (CRSP) in West Sumatra. She was a Women in Development Specialist for HITAHR during 1980-82 and an Investigator for the Indonesian-U.S. Man and Biosphere Project (1979-80).

J. LIN COMPTON is an Associate Professor of Extension and Adult Education at Cornell University. He spent a year in Thailand as a Fulbright researcher and lecturer in Rural Sociology, and two years in the Philippines as Head of the Education and Culture Department of the International Institute of Rural Reconstruction. During 1980-81, he was involved in short-term work in India, Sri Lanka, Korea, Indonesia, Malaysia, and Thailand.

FRANK CONKLIN is a Consortium for International Development (CID) Fellow serving as Deputy Director for the Egypt Major Cereal Improvement Project and the Tanzania Farming Systems Project. He is also a Professor in the Department of Agricultural and Resource Economics at Oregon State University (on leave). Conklin was a Research Associate and Visiting Professor at the National Agricultural College and the University of Nuevo Leon in Mexico (1966-68). He has consulted on projects in Turkey, Algeria, Venezuela, and Thailand.

JOHN DUNBAR is Dean of Agriculture and Director of the Agricultural Experiment Station at Kansas State University (KSU). He was formerly Director of the Cooperative Extension Service at KSU (1976-80) and Associate Director of the Cooperative Extension Service and the Agricultural Experiment Station at Purdue University. Dunbar has served as a consultant to the National Food and Agricultural Council of the Philippines (1978, 1979, 1980) and as a consultant in Pakistan, Iran, and Turkey.

SURYATNA EFFENDI is Director of the Sembawa Rubber Research Institute for Smallholder Rubber in Palembang, Indonesia. He was head of the Bogor Research Institute for Food Crops (1980); and he has been with the Central Research Institute for Agriculture in Bogor, Indonesia since 1958. Effendi received his Ph.D. in 1976 at the University of the Philippines in Los Baños.

CORNELIA BUTLER FLORA is a Professor of Sociology at Kansas State University and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. She served for two and a half years with the Ford Foundation, based in Bogota, Colombia, as Program Advisor for Agriculture and Rural Development for the Andean Region and Southern Cone of South America. She has served as a consultant for women in development programs and rural development programs in many countries of Latin America and the Caribbean. Her research and consulting activities have taken her to Mexico, Cuba, Colombia, Ecuador, Brazil, Peru, Argentina, Chile, Venezuela, Uruguay, Nicaragua, Barbados, and the Dominican Republic.

PATRICIA GARRETT is an Assistant Professor in the Department of Rural Sociology at Cornell University. She is involved in research on subsistence production in Chile; and agronomic, sociological, and genetic aspects of bean yield and adaptation, in collaboration with research institutions in Guatemala and Ecuador. During 1970-73, Garrett was involved in field research in Chile, and was a Research Associate (1971) of the Centro de Estudios de la Realidad Nacional, Universidad Católica de Chile.

PETER HILDERBRAND is a professor of Food and Resource Economics and Coordinator of the Farming Systems Program at the University of Florida where he is advising the department and the Institute of Food and Agricultural Science on small-farm farming systems programs in other countries; assisting in the design of a multi-disciplinary pilot research and extension project of farming systems for Florida agriculture; and establishing an international farming systems training program. During 1974-80, he was responsible for the development of the Socioeconomics Unit for an Instituto de Ciencia y Technologia Agricolas (!CTA) project in Guatemala. Hildebrand was also Head of the Agricultural Economics Department at the Center for Agricultural Technology (CENTA) in El Salvador (1972-74).

WILLIAM JUDY is Senior Agricultural Research Officer, Africa Bureau, at the U.S. Agency for International Development, Washington, D.C. He was Acting Project Leader and Research Agronomist for the U.S. Department of Agriculture in Pakistan (1975-77), and Research Agronomist in Tanzania (1970-75). Judy has also been a consultant on projects in the Dominican Republic, Egypt, and Iraq.

GEORGE LARSON is a Professor of Agricultural Engineering at Kansas State University (KSU) and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. He was a consultant on the KSU-Philippines Integrated Agricultural Production and Marketing Project (1978-80), and a Professor of Agricultural Engineering and Head of the Department of Agronomy at Ahmadu Bello University in Zaria, Nigeria (1972-74).

VERNON LARSON is Director of International Agricultural Programs at Kansas State University (KSU). He was Chief of Party of the KSU/USAID team involved in developing Andhra Pradesh Agricultural University in India (1970-72). Larson was also Kansas State Team Leader, Dean of Agriculture, and Professor and Head of Animal Science at Ahmadu Bello University in Zaria, Nigeria (1966-68). In 1959 and 1962, he was Assistant Dean of Agriculture at the American University of Beirut in Lebanon.

JUAN CARLOS MARTINEZ is a Regional Economist for Central America and the Caribbean at the International Maize and Wheat Improvement Center (CIMMYT) in Mexico. During 1977-78, he was leader of the Organization for American States (OAS) Rural Development Projects in Mexico and El Salvador, and was a consultant for the OAS in Chile and Peru in 1976-77. Martinez was also a Professor and Director of the Department of Economics and Graduate Program in Agricultural Economics at the Instituto Nacional de Technologia Agropecuaria in Argentina from 1971-76.

J. KENNETH MCDERMOTT is Program Officer for the International Agricultural Development Service (IADS), Washington, D.C. Until recently, he was Associate Director in the Office of Agriculture of the USAID's Bureau of Science and Technology. McDermott was the Agricultural Development Officer for the USAID mission to Colombia (1976-80), and Associate Professor (1961-63) and Chief of Party (1963-65) for the Purdue-Brazil Project, Viçosa, Minas Gerais, Brazil.

RICHARD MORSE is a Research Associate at the East-West Resource Systems Institute in Honolulu, Hawaii. He was a Farming Systems resource person with the Hawaii Institute of Tropical Agriculture and Human Resources (1981-82) and a Visiting Professor in India (1980-81). Morse has been involved in consultancies in India (1958-60, 1964-66), Colombia (1962), and Burma (1950-53, 1954-56).

LUIS NAVARRO is Technical Coordinator in the Crops Production Department of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) in Turrialba, Costa Rica. He has been a consultant on various aspects of FSR-type projects for the Food and Agriculture Organization of the United Nations, the U.S. Agency for International Development, and Cornell University.

DAVID W. NORMAN is a Professor of Agricultural Economics at Kansas State University and Chief of Party, Agricultural Technology Improvement Project, USAID/Botswana. He has worked extensively in Nigeria at Ahmadu Bello University as part of a Kansas State University/AID project there. While in Nigeria, he began work on farming systems and is one of the pioneers in farming systems research. While at Ahmadu Bello University, he was head of the Department of Agricultural Economics and Rural Sociology. He has participated in many of the early workshops and working groups involved with defining the farming systems research approach and methodology, which has taken him to other parts of Africa, Asia, and Latin America, as well as Great Britain, his native country.

DAVID NYGAARD is Head of the Farming Systems Program at the International Center for Agricultural Research in the Dry Areas (ICARDA) in Aleppo, Syria. His Ph.D. thesis topic - Risk and Allocative Errors to Imperfect Information: The Impact on Wheat Technology in Tunisia-won the Outstanding Thesis Award by the American Association of Agricultural Economists (1980). During 1966-68, Nygaard was a Peace Corps Volunteer in Garian, Lybia.

EDGARDO QUISUMBING is the Government of the Philippines' Overall Project Coordinator for the KSU-Philippines Integrated Agricultural Production and Marketing Project. He is also Deputy Executive Director of the Philippine National Food and Agricultural Council and is a Visiting Professor of Horticulture at the University of the Philippines in Los Baños. Quisumbing was an Outstanding Young Men of the Philippines Awardee for Agriculture in 1977.

MICHAEL SCHULMAN is an Assistant Professor of Sociology at North Carolina State University (NCSU). He is co-leader of two projects under NCSU's Title XII Strengthening Grant: "Technology Transfer and Adaptation to Small Farms in North Carolina" and "Technology Transfer and Adaptation to Limited Resource Farmers" (Peru). Schulman is also a consultant on the North Carolina Mission to Peru.

WILLIS SHANER is an Associate Professor of Industrial Engineering at Colorado State University. He is Project Director of an USAID-funded Consortium for International Development project on farming systems research and development methodology. Shaner is also Associate Managing Project Director of an USAID-funded water management project for improving irrigation practices and farmers' conditions in the developing countries. He is co-author of "Farming Systems Research and Development: guidelines for Developing Countries."

MEREDITH SMITH is an Assistant Professor of Foods and Nutrition at Kansas State University (KSU) and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. She was Technical Advisor to the USAID's Office of Nutrition and its mission in the Dominican Republic (1980) on a nutrition survey for the Plan Sierra rural development project. Smith was also a Nutrition Consultant for the Universidad Católica Madre y Maestra and the Plan Sierra in 1979.

MYRON SMITH is currently assigned to the Board for International Food & Agricultural Development (BIFAD) as Agricultural Development Officer responsible for reviewing all AID financed projects for agricultural development. He has served overseas in a variety of positions, including agricultural development officer in Mali, Indonesia, soils advisor for fertilizer marketing in India, and short-term assignments in Africa. He has also worked as a county agricultural agent in Illinois and a district soils scientist for the U.S. Soil Conservation Service.

JOHN WHEAT is a Professor of Animal Sciences and Industry at Kansas State University (KSU) and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. He was on the agricultural faculty at Ahmadu Bello University, Nigeria (1966-68), where he taught animal genetics. Wheat was also beef cattle breeding advisor to the Ministry of Animal and Forest Resources of the former Northern Region of Nigeria during that time. His short-term experience in developing nations includes Costa Rica, Haiti, and Taiwan.

WILLIAM WHELAN is an Assistant Professor of Agricultural Economics and Marketing at Rutgers University. He recently completed his Ph.D. dissertation on "The Determinants of Food and Calorie Consumption for Farm Households in the North of Nigeria," an area that is involved in farming systems research. Whelan teaches courses in international agriculture and world food problems.

DWIGHT WIEBE is an Assistant Professor/Coordinator of the Dual-Degree Program in Agriculture at Kansas State University (KSU) and a Program Associate under the Farming Systems Research component of the University's Title XII Strengthening Grant. He developed the Dual-Degree Program and is author of the article "Dual-Degree--A New Concept for Third World Development." Wiebe is also involved with Kansas/Paraguay Partners.

L. VAN WITHEE is a Professor of Agronomy at Kansas State University (KSU) and Director of the Farming Systems Research component of the University's Title XII Strengthening Grant. He was Assistant Dean of Agriculture at Ahamadu Bello University, Zaria, Nigeria from 1966-68. Withee was a member of the KSU team that carried out the recommendation domain study for the Botswana Agricultural Technology Improvement Project in 1981, and is currently the Agronomy Backstopper for the project.

HUBERT ZANDSTRA is Associate Director (Animal Sciences) at the International Development Research Centre (IDRC), Agriculture, Food, and Nutrition Sciences Division in Vancouver, British Columbia, Canada. During 1975-80, he was Head of the Multiple Cropping Department and Program Leader for the Cropping Systems Program of the International Rice Research Institute (IRRI) in the Philippines. Zandstra is coauthor of the book "A Methodology for On-Farm Cropping Systems Research."

SYMPOSIUM REGISTRANTS

Belhassen Abdelkafi
UMC-Ag. Econ. Dept.
705 Hitt Street
Columbia, MO 65211

Bob Akim Abebayo
Kansas State University
M-27 Jardine
Manhattan, KS 66506

Inmaculada Adames
Plan Sierra
Apartado Postal 1153
Santiago de los Caballeros
Dominican Republic

Rob Aiken
Small Farm Res. Project
P.O. Box 736
Hartington, NE 68739

Jocelyne Albert
Ag. Economist
PPC/WID USAID
Washington, DC 20008

Chibinga Aliya
Utah State University
P.O. Box 1306
Logan, UT 84322

Habib Amamou
Ingenieur Principal
4 Rue Farhat Halhed Sahlia,
TUNISIA

Frank Anderson
ILCA
P.O. Box 5689
Addis Ababa, ETHIOPIA

Jose Roman Arauz
IDIAP
David, Chiriqui
PANAMA

Jay W. Artis
Michigan State Univ.
Dept. of Sociology
East Lansing, MI 48824

Nancy Axinn
Bean/Cowpea CRSP
200 Center for Intern'l Programs
Michigan State Univ.
East Lansing, MI 48824

Qazi Azam
Washington State Univ.
Box 2419 C-S
Pullman, WA 99163

Jacques Backer
Animal Science & Food PDAI
FAMV/PDAI
Haiti, W.I.
Port-au-Prince Damien

Linda Baer
Title XII - SDSU
South Dakota State Univ.
Scobey Hall 226
Brookings, SD 57007

Judith Mbula Bahemuka
Cornell University
International Agriculture
252 Roberts Hall
Ithaca, NY 14853

Wilbur Ball
California State Univ.
Cedar & Shaw Avenue
Fresno, CA 93740

Seth Beckerman
Washington State Univ.
Cooperative Extension
Pullman, WA 99164-6230

Washington Bejapana
CATIE - Costa Rica
P.O. Box 178
David, PANAMA

Janet Benson
Kansas State University
Depts. of Soc. & Anth.
Manhattan, KS 66506

Tareke Berhe
Agronomist
Kansas State University
Manhattan, KS 66506

Richard Bernsten
Winrock International
Route 3
Morrilton, AR 72110

John Bishop
AID
Science & Industry
Washington, DC 20523

H.C. "Skip" Bittenbender
Michigan State University
Dept. of Horticulture
East Lansing, MI 48824

Gordon E. Bivens
Iowa State University
40 LeBaron Hall
Ames, IA 50011

Michael Boating
Tuskegee Institute
Dept. of Agriculture
Milbank Hall
Tuskegee, AL 36088

Vaughn Brown
Colorado State University
501 North Taft Hill
Fort Collins, CO 80521

Kwasi Bruce
Colorado State University
Dept. of Economics
Fort Collins, CO 80523

Marvin Burns
Tuskegee Institute
Dept. of Agriculture
Milbank Hall
Tuskegee, AL 36088

David Burris
696 North Armour
Wichita, KS 67206

Rebecca Burt
Auburn University
Funchess Hall
Agronomy Department
Auburn, AL 36849

Charles Bussing
Kansas State University
Geography Department
Dickens Hall
Manhattan, KS 66506

Robert O. Butler
Washington State Univ.
P.O. Box 2208, College Station
Pullman, WA 99163

Susan Casement
Kansas State University
Farrell Library
Manhattan, KS 66506

John Caldwell
VA Polytechnic Institute
and State University
Dept. of Horticultural
Blacksburg, VA 24061

Shankariah Chamala
University of Queensland
Dept. of Agriculture
St. Lucia 4067
Brisbane, AUSTRALIA

Christina Chang
Kansas State University
N-28 Jardine Terrace
Manhattan, KS 66502

James A. Chapman
Agricultural Economist IICA
San Jose, COSTA RICA

Robin Childs
California
Fresno, CA 93710

Kee-Chai Chong
Int'l Center for Living
Aquatic Res. Mgmt.
MCC P.O. Box 1501
Makati, Metro Manila
PHILIPPINES

Mary Clarke
Kansas State University
Home Economics Dept.
Manhattan, KS 66506

Carol J. Pierce Colfer
University of Hawaii
Tropsoils Project, HITAHR
Gilmore Hall, 3050 Maile Way
Honolulu, HI 96822

Lin Compton
Cornell University
Extension & Adult Ed.
Stone Hall
Ithaca, NY 14853

Frank Conklin
CID
8762 East Placita Bolivar
Tucson, AZ 85715

Jim Converse
Kansas State University
Sociology Department
Manhattan, KS 66506

C. Milton Coughenour
University of Kentucky
S-205 Ag. Science Bldg. North
Lexington, KY 40546

Eric Crawford
Assistant Professor
Michigan State Univ.
East Lansing, MI 48824

Jeanne Crouch
Colorado State University
Clark, C-306
Fort Collins, CO 80521

Andrew T. Daly
Kansas State University
General Agriculture
Manhattan, KS 66506

George Dawson
New Mexico State Univ.
P.O. Box 3169
Las Cruces, NM 88003

Patrick Debold
Kansas State University
118 West Republic (home)
Salina, KS 67401

Olimpio M. De Guia Jr.
Farming Systems Develop
Project Eastern Visayas
Talloban City 7101
PHILIPPINES

Vernon Deines, Director
Kansas State University
Center for Reg. Comm. Planning
Seaton Hall
Manhattan, KS 66506

Ejigou Demissie
Lincoln University
3030 Founders Hall
Jefferson City, MO 65101

Dennis Demmel
Small Resources Project
P.O. Box 736
Hartington, NE 68739

Stanley Dennis
Kansas State University
Dept. of Pathology
College of Vet. Medicine
Manhattan, KS 66506

Sixto Desir
Faculté d'Agronomie
Départment de l'Agriculture
Damien, Port-au-Prince
Haiti, W.I.

Richard Dick
Iowa State University
Agronomy Department
Ames, IA 50011

Robert Dimit
Title XII - SDSU
Scobey Hall
Brookings, DS 57007

Daniel J. Dunn
Montana State University
Dept. of Economics
Bozeman, MT 59717

Doris Dyck
Bethel College
78 Warkentine Court
N. Newton, KS 67117

Suryantna Effendi
Balai Penelitian Perkebunan
Sembawa
P.O. Box 127, Palembang
INDONESIA

Jerry Eckert
Gambian Mixed Farming Project
Economics Department
Colorado State Univ.
Ft. Collins, CO 80523

L.E. Erickson
Kansas State University
Chemistry Eng. Dept.
Manhattan, KS 66506

Merle L. Esmay, Prof.
Ag Engineering
Michigan State Univ.
E. Lansing, MI 48824

Hashim Fatehally
Bethel College
Mod. 2B, Warkentine Ct.
N. Newton, KS 67117

Donald Ferguson USDA
Off. of Int. Coop & Dev.
Rm 104, 1735 N. Lynn St.
Arlington, VA 22209

Robert Finley
Prof. of Ag Economics
Univ. of Missouri
Columbia, MO 65211

Billie & Leonard Flora
Quinter, KS 67752

Cornelia Butler Flora
Kansas State University
Soc, Anthro., & Soc. Wk.
Manhattan, KS 66506

Jan L. Flora
Kansas State University
Dept. of Sociology
Manhattan, KS 66506

James Floyd
Ft. Riley State College
Ft. Riley, GA

Timothy Frankenberger
Univ. of Kentucky
Ag. Science Bldg. North S-207 A
Lexington, KY 40546

Russell Freed
Michigan State Univ.
Crop & Soil Science Dept.
E. Lansing, MI 48824

Gloria Freeland
Kansas State University
Intern'l Trade Inst.
1627 Anderson
Manhattan, KS 66506

Jim French
Univ. of Missouri
316 Muford Hall
Columbia, MO 65201

Pat Garrett
Cornell University
Rural Sociology
Ithaca, NY 14853

Cherie Geiser
Kansas State University
Food & Feed Grain Inst.
Shellenberger Hall
Manhattan, KS 66506

Emiliano Gianzo
Ministry of Agriculture
PHILIPPINES

Elon Gilbert
6968 S. Boulder Road
Boulder, CO 80303

Lawrence Goodman
Mid-America Nazarene
College
Olathe, US 66061

James Gulley
Intern'l Training Div.
U.S. Dept. of Agriculture
Room 3534-S
Washington, DC 20250

David Gullman
Bethel College
Box 48
North Newton KS 67117

Sara Guthrie, Consult.
Winrock International
404 N. 9th Street
Indiana, PA 15701

Mary Helen Haas
Colorado State Univ.
Dept. of Fac. Educ.
Ft. Collins, CO 80523

Fazlul Hague
S.S.O. (Farms)
Bari, Joydebpur
Dhaka, BANGLADESH

Craig Harris
Michigan State Univ.
Dept. of Sociology
E. Lansing, MI 48824

Ira Harritt
Kansas State University
University for Man
1221 Thurston
Manhattan, KS 66502

James Hassan
Kansas State University
D-10 Jardine Terrace
Manhattan, KS 66502

Zane Helsel
Univ. of Missouri
Agronomy Department
214 Waters
Columbia, MO 65211

Peter Hildebrand
Univ. of Florida
Food and Resource
Economics
McCarty Hall
Gainesville, FL 32611

Carol Hodne
U.S. Farmers Assoc.
422 1st Street, S.W.
Hampton, IA 50441

Patricia Hoye
University of Wyoming
P.O. Box 4074
Laramie, WY 82071

Jane Johnson
1104 Vattier, Apt. #10
Manhattan, KS 66502

John Johnson
Kansas State University
Farrell Library
Manhattan, KS 66506

William Johnson, Director
Kansas State University
Eng. Exper. Station
Seaton Hall
Manhattan, KS 66506

Jim Jorns
Kansas State University
Intern'l Agriculture
Waters Hall
Manhattan, KS 66506

Robert Jordan
Kansas State University
W-Jardine Terrace
Manhattan, KS 66502

Bill Judy
U.S. Agency for Int. Dev.
Room 2941, NS
Washington, DC 20523

Cheik Kamate
Michigan State Univ.
209 Berkey Hall
E. Lansing, MI 48824

Terry Kelly
Colorado State Univ.
408 La Ponte Avenue
Ft. Collins, CO 80521

Judith Kidd
Colorado State Univ.
Grad School of Ag Econ.
Ft. Collins, CO 80521

Clarissa Kimber
Geography Dept, Int. Prog.
Texas A & M University
College Station, TX 77843

Christine Knox
1313 Ady Drive
Manhattan, KS 66502

Berl Koch
Animal Science & Ind.
Kansas State University
Call Hall
Manhattan, KS 66506

Bernice Kopel
Oklahoma State Univ.
Food & Nutrition Dept.
Stillwater, OK 74078

Steven Kraft
Assistant Professor
Dept. of Ag. Bus. Econ.
Carbondale, IL 62901

Ron Krupicka
Small Farm Res. Project
P.O. Box 736
Hartington, NE 68739

Gene Kuntz
Rural Ventures, Inc.
2001 Killebrew Drive
Bloomington, NM 55420

Beth Labaugh
Colorado State Univ.
10141 W. Mountain
Ft. Collins, CO 80521

George Larson
Kansas State University
Ag. Engineering
Manhattan, KS 66506

Vernon Larson, Director
Kansas State University
International Agricultural Program
Waters Hall
Manhattan, KS 66506

G.R. Jack Law
Colorado State Univ.
1201 Robertson Street
Fort Collins, CO 80524

Gary Lemme
SDSU - Title XII
Scobey Hall #226
Brookings, SD 57007

Joe Lesiak
Center For Rural Affairs
P.O. Box 405
Walthill, NE 68067

Martin Limbird
Iowa State University
E.O. Building
Ames, IA 50011

Ken McDermott
International Ag. Dev. Services
Suite 600
611 North Kent St.
Arlington, VA 22209

Greg McIsaac, Instructor
Univ. of Wisconsin
Dept. of Ag. Eng. Tech.
River Falls, WI 54022

Paul McKay
Bethel College
Dept. of Int'l Dev.
N. Newton, KS 67117

J. Wendel McKinsey
Univ. of Missouri
2-69 Agriculture
Columbia, MO 65211

Juan Carlos Martinez
CIMMYT
Apdo. Postal 6-641
Mexico 6, D.F.
MEXICO

Enrique Mayer
109A Davenport Hall
Dept. of Anthropology
Urbana, IL 61801

Susan Miller
Kansas State University
Farrell Library
Manhattan, KS 66506

Craig Morris
Kansas State University
Agronomy Department
Manhattan, KS 66506

W.H.M. Morris
Purdue University
West Lafayette, IN 47907

Charles Morrow
Mid-America Nazarene Coll.
Olathe, KS 66061

Richard Morse
East West Center Resource
Systems Inst.
1777 East West Road
Honolulu, HI 96848

Manassee Rimmy Mtoi
Agricultural Economist
School of Ag Economics
University of Guelph
Guelph, Ontario, Canada
NIG 2W1

J. Thomas Mulleady
Iowa State University
324 Curtiss Hall
Ames, IA 50011

Luis Navarro
CATIE
Turrialba
COSTA RICA

George Naylor
U.S. Farmers Assoc.
Route 1, Box 110
Churdan, IA 50050

M. Duane Nellis
Kansas State University
Dept. of Geography
Manhattan,KS 66506

Richard L. Ness
Iowa State University Ext.
P.O. Box 877
Fort Dodge, IA 50501

Beatrice Ncube
Kansas State University
B-12 Jardine Terrace
Manhattan, KS 66502

Mark D. Newman
Kansas State University
Dept. of Ag. Economics
Waters Hall
Manhattan, KS 66506

David Nygaard, Head
Farming Systems Program
Intern'l Center for Ag.
Res. in the Dry Areas
P.O. Box 5466
Aleppo, SYRIA

Daniel Michael O'Brien
Cooperative Extension
Service
602 East C
North Platte, NE 69101

Azariah Ogal
USDA Office of Int'l Gov.
Room 3534-S
Washington, DC 20250

Farrel Olsen
Southern Illinois Univ.
Dept. of Plant & Soil Science
Carbondale, IL 62901

Abdallah Omezzine
UMC
Ag. Economics Dept.
705 Hitt Street
Columbia, MO 65211

Donald Osburn
1701 Oakwood Ct.
Columbia, MO 65201

James Oxley, Director
Int'l Agriculture Prg.
CSU-College of Agriculture
Science
121 Shepardson

Santiago J. Pablo
Supervising Agronomist
Bureau of Plant Industry
San Andres, Manila
PHILIPPINES

Larry Paris
Kansas State University
N-28 Jardine Terrace
Manhattan, KS 66506

Wilfred Pine
Kansas State University
Economics Department
Waters Hall
Manhattan, KS 66506

Carolyn Pribble
Int'l Agriculture
113 Mumford Hall
1301 W. Gregory Drive
Urbana, IL 61801

Maissor Nicolo Qahoush
Kansas State University
838 Moore Hall
Manhattan, KS 66506

Felix Quero, Project Director
Farming Systems Dev.
Project East. Visayas
Tacloban City 7101
PHILIPPINES

Edgardo Quisumbing, Dir.
Ag. Research Office
Ministry of Agriculture
Diliman, Quezon City 3008
PHILIPPINES

Michael D. Read
Colorado State Univ.
Ft. Collins, CO 80523

Dale Reeves
Plant Science Dept.
South Dakota State Univ.
Brookings, SD 57007

David Regehr
Kansas State University
Throckmorton Hall
Manhattan, KS 66506

Jennifer Reinbrecht
Title XII - SDSU
Scobey Hall #226
Brookings, SD 57007

Armando Reyes - Pacheco
Kansas State University
Ag. Economics Dept.
Manhattan, KS 66506

Katharine Riddle
Women in Dev. Coord.
University of Nebraska
International Programs
Lincoln, NE 68583

Charlotte E. Roderuck
World Food Institute of
Iowa State Univ.
102 East O. Bldg.
Ames, IA 50011

Mary Hill Rojas
Virginia Tech.-Wid. Director
1060 Animal Science Bldg.
Blacksburg, VA 24060

David Sammons
Univ. of Maryland
College Park, MD 20742

K. Reddy Sanath
USAID Bamako/MALI
Dept. of State
Washington, DC 20520

Paul E. Sanford
Kansas State University
Animal Science & Industry
Manhattan, KS 66506

Saiquo Sanou
Michigan State Univ.
309 Berkey Hall
E. Lansing, MI 48824

Frank Santopolo
Colorado State Univ.
Ft. Collins, CO 80523

Blas Antos
Plan Sierra
Apartado Postal 1153
Santiago de los Caballeros
DOMINICAN REPUBLIC

Djoko Santoso
% HITAHR, Asst. Dir. Res.
3050 Maile Way, Gilmore 2
Honolulu, HI 96822

Jasmin Sapin
Univ. of Missouri
316 Mumford Hall
Columbia, MO 65211

Mustafa Sawani
Univ. of Missouri
Mumford Hall #323
Columbia, MO 65201

Margaret Sawatzky
Bethel College
Commuter Box 81
N. Newton, KS 67117

Williard Schmehl
Colorado State Univ.
Dept. of Agronomy
Ft. Collins, CO 80523

David Schroder
Univ. of Missouri
310 Mumford Hall
Columbia, MO 65211

Michael Schulman
North Carolina State
University
Dept. of Sociology
P.O. Box 5428
Raleigh, NC 27650

James Sentz
Univ. of Minnesota
277 Coffey Hall
1420 Eckles Avenue
St. Paul, MN 55108

W.W. Shaner
Colorado State Univ.
College of Engineering
Ft. Collins, CO 80523

Wendy Sheppard
Kansas State University
Int'l Agriculture Prg.
Waters Hall
Manhattan, KS 66506

Meredith Smith
Kansas State University
Foods & Nutrition
Justin Hall
Manhattan, KS 66506

Myron Smith
Agency for Intern'l
Development
BIFAD/S Room 5318
Washington, DC 20523

M.T. Somobayee
Cornell University
International Agriculture
Ithaca, NY 14853

Jeffrey Steiner
California State Univ.
Plant Science Dept.
Fresno, CA 93740

Marty Strange
Center for Rural Affairs
P.O. Box 405
Walthill, NE 68067

John Tait
Iowa State University
303 D. East Hall
Ames, IA 50011

S. Morris Talley
Lincoln University
Hillcrest Building
Jefferson City, MO 65101

John E. Thompson
Title XII - SDSU
Scobey Hall
Brookings, SD 57007

John R. Thompson
University of Hawaii
461 Lanikaula Street
Hilo, HI 96720

G. Sue Thompson
Sam Houston State
University
Box 2012
Huntsville, TX 77341

William Thompson, Dir.
Intern'l Agriculture
University of Illinois
113 Mumford Hall
Urbana, IL 61801

Gary Thull
Kansas State University
International Trade
Center
1627 Anderson Ave.
Manhattan, KS 66506

Martha Tomecek
Kansas State University
Developing Countries
Farrell Library
Manhattan, KS 66506

Jill Underhill
Kansas State University
352 Goodnow Hall
Manhattan, KS 66506

Camilo Villanueva
Inter'l Programs
Texas A&M University
College Station, TX 77843

M. Villanueva
Texas A&M University
International Programs
College Station, TX 77843

Donald Voth
University of Arkansas
Dept. of Ag Economics &
Rural Sociology
Fayetteville, AR 72701

Mike Wade
University of Hawaii
3190 Maile Way
Honolulu, HI 96822

Neal Walker
University of Tennessee
Ag Economics Department
Knoxville, TN 37996

Richard G. Wall
Assistant Professor
Tabor College
Hillsboro, KS 67263

Gerald Ward
Colorado State University
Dept. of Animal Science
Ft. Collins, CO 80524

Lowell Watts
Colorado State University
Extension Service
201 Administration
Ft. Collins, CO 80523

Celia Jean Weidemann
Chief Institutional &
Human Resources
BIFAD/AID, 5318 USAID
Washington, DC 20523

John Wheat
Kansas State University
Animal Science Department
Weber Hall
Manhattan, KS 66506

William Whelan
Cook College - Rutgers Univ.
Dept. of Ag Econ & Marketing
P.O. Box 231
New Brunswick, NJ 08903

Dwight Wiebe
Adult & Occupational Educ.
Bluemont Hall
Kansas State University
Manhattan, KS 66506

Wendell Wiebe
Bethel College
Box 301
N. Newton, KS 67117

Stephen Wiebe Johnson
Bethel College
1410 Oak
Newton, KS 67114

Gerald Wilde
Kansas State University
Entomology Department
Waters Hall
Manhattan, KS 66506

L.V. Withee
Kansas State University
Dept. of Agronomy
Throckmorton Hall
Manhattan, KS 66506

Donald Wood
Colorado State University
Dept. of Agronomy
Ft. Collins, CO 80523

Michael James Yates
CIMMYT/Outreach
% DARNDR/SERA B.P. No. 9
Les Cayes, Haiti (W.I.)

Russell Yost
University of Hawaii
3190 Maile Way
Honolulu, HI 96822

Hubert Zandstra
Int'l Dev. Res. Center
5990 Iona Drive
Univ. of British Columbia
Vancouver, CANADA V6T 1L4

PRESENTERS INDEX


| | |
|---|---|
| Axinn, Nancy | 226 |
| Bernsten, R. H. | 245 |
| Butler Flora, Cornelia | 20 |
| Compton, J. Lin | 229 |
| Conklin, Frank S. | 182, 241 |
| Effendi, Suryatna | 49 |
| Garrett, Patricia | 215 |
| Judy, William H. | 156 |
| Martinez, Juan Carlos | 99 |
| McDermott, J. K. | 198 |
| McIntosh, Jerry L. | 49 |
| Morse, Richard | 285 |
| Navarro, Luis A. | 126 |
| Norman, David W. | 6 |
| Nygaard, David | 76 |
| Pierce Colfer, Carol J. | 206 |
| Quisumbling, Edgardo C. | 146 |
| Roman Arauz, Jose | 99 |
| Schulman, Michael D. | 275 |
| Shaner, W. W. | 162 |
| Smith, Myron | 278 |
| Whelan, William P. | 264 |
| Zandstra, Hubert G. | 33 |

TITLE INDEX


| | |
|---|---|
| Complementary Aspects of Rural Energy and Farming Systems | 285-299 |
| Cropping and Farming Systems Research in Indonesia | 49-75 |
| Developing Technology for Small Farms: A Case Study in Central America | 126-145 |
| Evaluating Impact in Farming Systems Research and Development Projects – A Neglected Issue | 245-263 |
| The Farming Systems Approach to Research | 6-19 |
| Farming Systems Research and the Land Grant System: Transferring Assumptions Overseas | 20-32 |
| FSR Project Evaluation | 198-205 |
| FSR/E as a Field Methodology in Third World Countries: Its Historical Origins, Current Functions, and Suggestions for Improvement | 182-197 |
| Goal Conflict and Incentives Among Institutional Participants | 226-228 |
| Identifying Appropriate Target Populations | 215-225 |
| Incorporating Nutritional Considerations into Farming Systems Research | 264-274 |
| Institutional Innovations in National Agricultural Research: On Farm Research within IDIAP, Panama | 99-125 |
| Integrating Participants: Farming Systems Lessons from Hawaii | 206-214 |
| Linking Farming Systems Research and Extension to the Farmer— The Philippine Experience | 146-155 |
| Linking Scientist and Farmer: Re-Thinking Extension Role | 229-240 |
| Long Term vs. Short Term Consultancies: Advantages and Disadvantages from an AID Mission Viewpoint | 278-284 |
| Organizational Deficiencies of Technical Assistance Projects Including FSR/E: Points of Departure for Discussion | 241-244 |
| An Overview of On-Going Applied Farming Systems Development Projects: What are Farming Systems and How do They Relate to Development? | 33-48 |
| Relation of Farming Systems Research to Component Research Programs | 156-161 |

TITLE INDEX - 2

Stratification: An Approach to Cost-Effectiveness for Farming Systems Research and Development 162-181

Tests on Farmers' Fields: The ICARDA Experience 76-98

Translation of Station Experimental Work to Farmer's Field 275-277