WORKING TOGETHER

Gender Analysis in Agriculture

Editors

Hilary Sims Feldstein
Susan V. Poats

VOLUME 1: Case Studies

KUMARIAN PRESS

PN-ABJ-361

isn-73644

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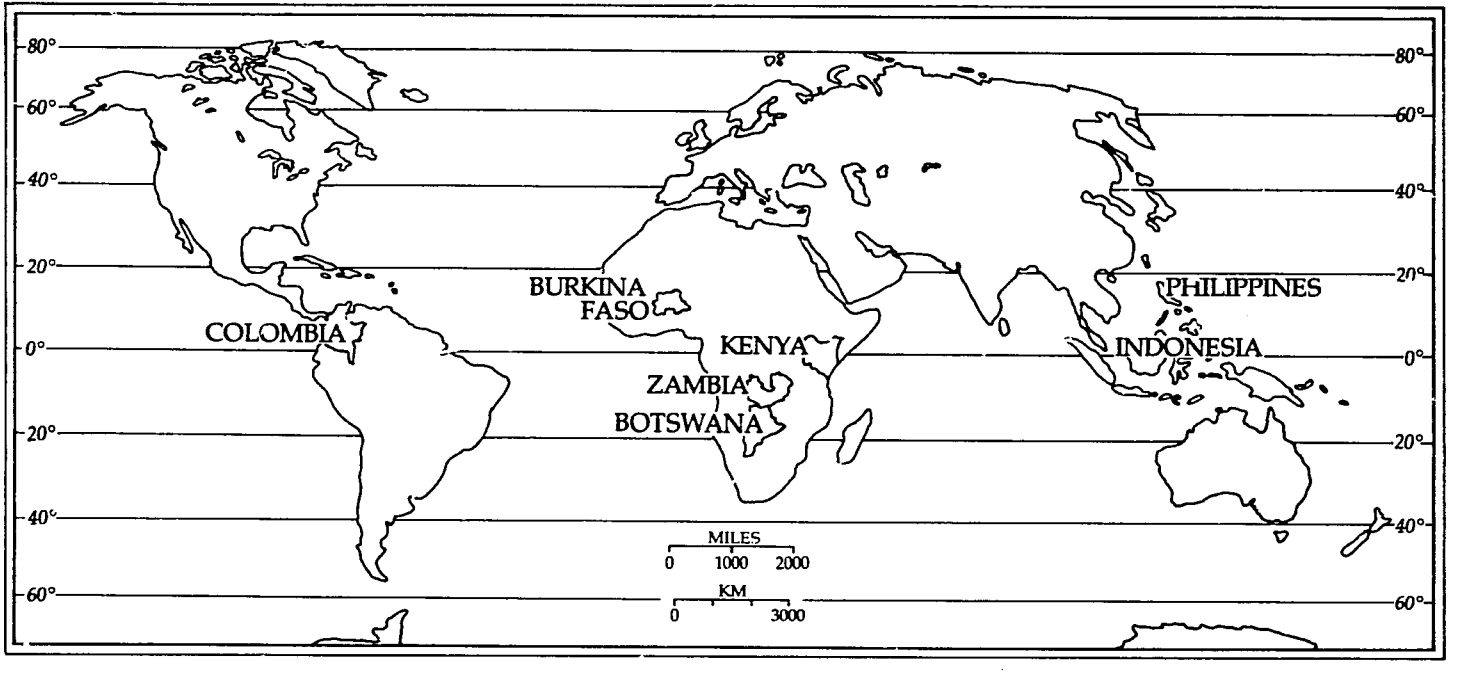
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Working Together

Gender Analysis in Agriculture

Volume 1
Case Studies

Editors

HILARY SIMS FELDSTEIN
AND SUSAN V. POATS

KUMARIAN PRESS

Dedication

These volumes are dedicated to our husbands and children who have given us unstinting emotional support and who have transcended roles defined by gender or age to give us the space and time to complete this work.

To Lew and Julio, and Sarah, Robert, Rushuma, and Nicholas

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First printing in the United States of America, 1990
94 93 92 91 90 5 4 3 2 1

Cover design by Marilyn Penrod
Figures by Paloma Ibarra
Edited by Erica Swanson
Proofread by Ruth M. Wilson

Phototypeset by Johnson Publishing Company

Library of Congress Cataloging-in-Publication Data

Working together : gender analysis in agriculture / edited by Hilary Sims Feldstein and Susan V. Poats.
p. cm. — (Library of management for development) (Kumarian Press case studies series)
Includes bibliographical references.
Contents: v. 1. Case studies — v. 2. Teaching notes.
ISBN 0-931816-58-0 (v. 1) — ISBN 0-931816-59-9 (v. 2)
1. Agricultural systems—Research—Case studies. 2. Women in agriculture—Research—Case studies. 3. Agricultural extension work—Case studies. 4. Farms, Small– Case studies. 5. Agricultural systems—Research—Developing countries—Case studies. 6. Women in agriculture—Research—Developing countries—Case studies. 7. Agricultural extension work—Developing countries—Case studies. 8. Farms, Small—Developing countries—Case studies. I. Series. II. Series: Kumarian Press case studies series.
S494.5.S95W65 1989 90-4287
630'.72—dc20 CIP

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Foreword

One phrase in particular caught my eye in the introduction to the conceptual framework for the case studies in this volume:

> Farmers, product users, researchers, and policy makers all have preferred outcomes.

I often feel that if we could induce the same preferred outcome for these several levels of interest, such a common denominator for policy and processes would bring a synergy to development efforts. Two factors amongst others have created a centrist tradition in many developing countries: the distancing of officials and professional people from the culture and life of poorer rural people and their assumption that education and officialdom provide a unique wisdom for guiding the fate of other people. Priorities, policies, programs, and projects decided at the national level have been imposed locally by caveat.

Persistent failure is eroding this centrist tradition. There is a shift toward decentralization, local specificity, and participation. The shift has been fostered by the realization that, where a majority of the population are resource-poor small farmers, their decisions, seeking to improve their own productivity, also drive the economy. They, not government officials, are the real arbiters of the state of the nation. It is being reinforced by increasing, and indeed admiring, understanding of the rational efforts of poorer people to take care of and improve themselves.

A major implication of this shift is that research and development (R & D) efforts must offer farmers new techniques which are attractive to them as well as good for the country. This in its turn brings a need for better understanding of farmers' priorities and problems to allow reconciliation with national issues. The implications for changes in R & D processes are profound.

It is in terms of these R & D processes that these two volumes, compiled and edited by Hilary Sims Feldstein and Susan V. Poats, make their contribution.

Over the last fifteen years farming systems research (FSR) has begun to allow a weighing of farmers' perspectives in the research and development process. Some progress has been made both in the introduction of FSR into developing country research and extension institutions and in exploring input from the farm level through FSR to the policy formulation process. The same period has brought an awareness to many policy makers and re-

searches that women are major contributors to development and that male-dominated institutions have produced male-biased programs.

The link between these two coincident themes is that FSR, as a process, provides a means to understand the role of women in agriculture, their importance to improved agricultural productivity, and hence their importance as a focus for research and extension.

Feminism and the importance of women in development are often compounded. The active stance taken by women professionals working in development has been effective. It is heartening to see that assertiveness is underpinned by a professionalism in bringing together, in these case studies, the nuts and bolts of a process that will both help achieve a dream and further development.

The emphasis of the case studies is that "the household" is not a homogeneous male-driven decision-making unit:

> Adult women, the elderly, and children bring specific skills, resources, and priorities to farm production. To ignore these is to ignore half or more of the system in which decisions about farming are made.

The household is itself "a system of resource allocation." The cases bear this out in unequivocal detail. The conclusion has to be that careful analysis of intrahousehold relationships will help confirm the value of emerging farmer-based processes and programs in development. To continue to mistreat the household as the domain of the adult male will threaten the credibility of these processes by limiting their impact on technology adoption.

The cases and the teaching notes assembled in these volumes represent a valuable resource for those engaged in building the human and institutional capacity to pursue a people-oriented development process. They will be of particular value to universities and colleges interested in exposing their students to a wider variety of teaching methods and to agricultural research and development institutions, such as the Centro Internacional de Mejoramiento de Maiz y Trigo and the Women in Rice Farming Systems network, which conduct training and workshops. The studies also offer real-world material on small-farm agriculture, which itself will contribute to a more understanding relationship between educated and rural people. Finally, the studies offer an entry point for a wide range of other sociological investigations; for example, the impact of migration, changed tenure, and other community or regional level development phenomena on household organization.

Michael Collinson
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Washington, D.C.

Preface

Over a decade ago, the Population Council embarked upon a program to elucidate the links between women's roles and population and development processes, particularly the achievement of national productivity and social welfare goals. One particularly promising avenue of inquiry was to learn how women were affected by large-scale development intervention. We reasoned that gender should rank with class as an axis along which social and economic effects were viewed. Our investigation of this subject—mounted initially as a diagnostic and sensitization exercise—began with a series of case studies relying upon the reanalysis of existing materials. Eight case studies (five of which were published) and two monographs were produced which highlighted and explored ways in which development schemes inadvertently (and sometimes by design) altered women's access to and control of basic productive resources.

When we critically evaluated this work, we identified several problems and deficits in the literature and in our approach that we wished to overcome with subsequent work.

The first problem was the relative dearth of information about Asia. Thus, under the leadership of Aruna Rao, a second set of case studies was commissioned from development theorists and practitioners based at major Asian institutions. These cases—numbering ten—analyze women's roles in significant agricultural and rural resource development schemes in Asia.

A second problem with case studies rested not in the soundness of their content, but rather in the uptake of their recommendations. Many studies over the last decade have concluded with recommendations for approaching women more effectively through mainstream programs, making special provisions to increase their access to credit and related services, experimenting with forms of individual and group agricultural extension to attract their interest in new technologies, and so forth. Both because of the blindness of most development projects to gender issues (including the use of the household as the smallest unit of analysis) and because of the form that development projects take (the tendency to plan all the inputs long in advance without experimentation in the project cycle), few recommendations were ever taken up. Without experimentation, the learning curve of the development community is halted. Thus, in searching for a sufficiently innovative and flexible development activity, we became interested in the potential of integrating gender concerns into farming systems research and extension.

Farming systems research and extension was promising on a number of grounds. Agriculture is a major absorber of women's labor. Farming systems projects have accounted for and continue to account for extraordinarily large portions of bilateral and multilateral agricultural funds. Finally, farming systems research and extension has an explicitly experimental style. Unlike many other development initiatives, it is not the case in farming systems research and extension that the monies committed are exhausted early in the implementation cycle, or that the plans determined in the first year are unalterably followed through the fifth. Indeed, in farming systems research and extension, a series of trials are undertaken to evaluate proposed new technologies and their adaptation and the design of the human service and technical organization that is meant to bring new productive opportunities to its clients: both male and female farmers. Thus, we developed, in collaboration with the Farming Systems Support Project of the University of Florida at Gainesville, a plan to produce case studies based on important farming systems research and extension projects which had explicitly taken gender into account. We drew up a request for proposals and expected between fifteen and thirty submissions. Instead we received over eighty, and the seven case studies contained in this volume were among those. Other useful materials will be found in the companion methodologies handbook to be published in 1991.

Another rewarding aspect of the search for materials on farming systems research and extension, apart from the numbers of interested investigators, was the variety of the material. The cases are from Africa, Asia, and Latin America. They range from soils to crops, livestock, and agroforestry, and they focus on different shapes of farming systems research and extension from diagnosis to on-farm experimentation to extension.

We at the Population Council wish to thank the Farming Systems Support Project for its assistance in the initial phases of the project. We specifically extend our thanks to Hilary Sims Feldstein and Susan V. Poats for their extraordinary leadership of this project. We commend our partners in this enterprise, those who have served in the initial advisory committees and have continued to serve on training teams and in informal advisory capacities. Finally, we are grateful to the Ford Foundation for its ongoing and trusting support of these activities. Ten years after the initiation of the larger program, we are proud that seven teaching case studies of such richness and depth will be available to the widening development community.

Judith Bruce
Senior Program Associate
Population Council
New York

Acknowledgments

These two volumes owe their existence to the support and hard work of a number of people and institutions. The Population Council and the Farming Systems Support Project (FSSP) of the University of Florida jointly sponsored the initial phase of the Gender and Agriculture Project, which was known at that time by the longer title of Intra-Household Dynamics and Farming Systems Research and Extension Case Studies Project. When the FSSP came to an end in 1987, the Population Council continued the project into its second phase (1988–90).

Initial funding for the project came from the Ford Foundation through the Population Council and from the United States Agency for International Development through the FSSP. The Ford Foundation increased the support for the project during phase I to allow more cases to be written and subsequently funded phase II in its entirety. We have greatly appreciated the ongoing support given to the project and the confidence expressed in our work by the Ford Foundation. In particular, we would like to acknowledge the support and guidance provided by the three project officers who have handled the Gender and Agriculture Project within the Office of Rural Poverty: Katharine McKee, Mildred Warner, and Cheryl Danley. Though changes in project officers often can cause disruption for a project, the changes we experienced were smooth and each has brought different and useful perspectives to the overall direction of the project.

The following people served as members of the advisory committee during the course of the project: Harry "Skip" Bittenbender, Kathleen Cloud, Frank Conklin, Cornelia Butler-Flora, Paula Goddard, Nadine Horenstein, Katharine McKee, Rosalie Norem, David Nygaard, Pauline Peters, Federico Poey, and Mary Rojas. We greatly appreciate their help in developing the case study format and the conceptual framework, in selecting the case studies, and generally in lending their collective expertise to this effort.

We would like to thank Remko Vonk, Marion von Schaik, Mahir Saul, Louise Fortman, Janice Jiggins, and Pauline Peters, who read and commented on earlier drafts of specific case studies. Jean Weidemann arranged with the Title XII Board for International Food and Agricultural Development (BIFAD) to invite us to conduct a workshop in advance of the 1987 Association for Women in Development meetings. Alistair Sutherland and Benchuphan Shinawatra provided excellent suggestions on how to edit the Botswana case study after using it as participants in a

training course. We owe special thanks to Martha Gaudreau who reviewed the entire text, paying special attention to the agricultural data presented.

Several of the FSSP staff members lent support to the project, read early drafts, and commented on the conceptual framework. We would like to particularly thank Chris Andrew, Dan Galt, Steve Kearl, Lisette Walecka, and Peter Hildebrand for their help and and interest in the project.

We would like to give a special thanks to all of the case study authors who worked very hard to turn their project information into useful teaching case studies. This is not an easy task and we are grateful for their time, perseverence, and patience as we developed, edited, tested, and reedited many of the case studies. Two other case studies, developed by Vasantha Chase and Eva Wollenberg, were not included in these volumes because of space and time limitations, but we hope they will be made available through other publications.

An important part of the development of the case studies has been testing them with a variety of audiences and incorporating the comments and suggestions of the participants who have used them. We would like to thank the following institutions or organizations that allowed us to test various versions of the cases during a wide range of conferences, workshops, annual meetings, and training courses: the Association for Women in Development (AWID), the Gender Issues and Farming Systems Research and Extension Conference at the University of Florida, the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) East and Southern African Economics Program, the Adaptive Research and Training Teams of the Department of Agriculture in Zambia, the International Rice Research Institute (IRRI) and the Women in Rice Farming Systems network (WIRFS), the Farming Systems Support Project, the Bean/Cowpea Collaborative Research Support Project (CRSP), and the University of Florida at which the cases were used in numerous academic courses. We would like to particularly thank Rosalie Norem and Kathleen Cloud who joined us in our early tests of the cases with various audiences.

This project has been supported by some very talented professionals who provided critical expertise in several important production areas. Not only were they efficient in accomplishing their tasks, but also they worked as collaborators, making suggestions on how to best present the material in the cases and teaching notes. Debra Tufts of Summit Software performed magical feats in turning rough text from a variety of sources into final copy, using Microsoft Word on an Apple Macintosh II. Her attention to substance as well as form was a great boon to the editors. Martha White did the initial entering of several case studies texts so that we would have clean copy to test and edit. Craig McKown redesigned and formatted all of the tables to fit our size and space limitations. Susan Marynowski designed the original gender disaggregated agricultural calen-

dar which was used as the model for all the other calendars in the volumes. Paloma Ibarra drew all the figures and maps. We appreciate her creativity in taking our rough sketches and making them into understandable drawings that illuminate many of the concepts described in the text. As copyeditor, Erica Swanson helped bring harmony to the whole as well as precision to our words. Jenna Dixon at Kumarian Press pulled the layout of the book together, polished our rough edges and made sure all the last details were in good order. We would like to thank our publisher, Krishna Sondhi, who throughout the lengthy editing process and technical complications continued to encourage the production of this book.

We owe a very special thanks to Mary Anderson and Catherine Overholt of the Collaborative for Development Action, who introduced us to the use of case method for training in gender analysis, trained us to teach by the case method, provided guidance and suggestions on how to develop case studies, and assisted us in training other trainers to use these case studies. We have relied extensively on their experience in developing the teaching notes contained in Volume 2.

Our final appreciation goes to three people who provided unique support to the project over its life. First of all, we want to thank Kathleen Cloud for being the theoretical and conceptual conscience for the project. She has been a strong supporter of the project and an active participant in the development of the conceptual framework. We owe a special thanks to Marianne Schmink who brought the Population Council and the Farming Systems Support Project together in the first place and who helped to conceive the initial idea for the Gender and Agriculture Project. That this project was launched and remains afloat is due to the generous, wise, thought-provoking and spirited support of Judith Bruce of the Population Council. Our thanks to her is bottomless.

Hilary Sims Feldstein
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Susan V. Poats
Gainesville, Florida

Acronyms

ACPO	Accelerated Crops Production Officers (Burkina Faso)
AFC	Agricultural Finance Company (Zambia)
ALDEP	Arable Land Development Program (Botswana)
APRU	Animal Production Research Unit (Botswana)
ARFSN	Asian Rice Farming Systems Network
ARPT	Adaptive Research Planning Teams (Zambia)
ATIP	Appropriate Technology Improvement Project (Botswana)
BAMB	Botswana Agricultural Marketing Board
BDP	Broadcast Double Plowing
BSP	Broadcast Single Plowing
CARE Kenya	CARE International in Kenya
CEC	Cation Exchange Capacity
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo
CRT	Central Region Team (Botswana)
D and D	Diagnosis and Design
DAFS	Department of Agricultural Field Services (Botswana)
DAR	Department of Agricultural Research (Botswana)
FAC	French Aid for Cooperation
FSR/E	Farming Systems Research and Extension
FSU	Purdue University/SAFGRAD Farming Systems Unit
HYV	High Yielding Variety
IARC	International Agricultural Research Center
IAS	Institute of Animal Science (UPLB)
IBRAZ	Institut Burkinabé des Recherches Agronomiques et Zootechniques (Burkina Faso)
ICRAF	International Council for Research on Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFDC	International Fertilizer Development Center
IITA	International Institute for Tropical Agriculture
IRAT	Institut de Recherches Agronomiques Tropicales
IRRI	International Rice Research Institute
KARI	Kenya Agricultural Research Institute
KEFRI	Kenya Forestry Research Institute

LINTCO	Lint Company of Zambia
MAWD	Ministry of Agriculture and Water Development (Zambia)
NAMBOARD	National Agricultural Marketing Board (Zambia)
NFA	National Food Authority (Philippines)
NIA	National Irrigation Administration (Philippines)
OAU	Organization of African Unity
OFNACER	Office Nationale de Céréales (Burkina Faso)
OFR	On-Farm Research
ORD	Organisme Regional de Développement (Burkina Faso)
PCV	Peace Corps Volunteer
RIARS	Regional Integrated Agricultural Research Station (Philippines)
RPEP	Row Planting after Early Plowing
SAFGRAD	Semi-Arid Food Grain Research and Development Project
SOFITEX	Société Voltaique des Fibres Textiles (Burkina Faso)
TAS	Time Allocation Study
TRD	Traditional Recommendation Domain
TSP	Triple Super Phosphate
UPLB	University of the Philippines at Los Baños
USAID	United States Agency for International Development
WIRFS	Women in Rice Farming Systems

Introduction

SUSAN V. POATS AND HILARY SIMS FELDSTEIN

Women are critical to agricultural production, but their access to resources and effective technologies is often constrained by gender barriers or blindness. This can lead to detrimental effects on the design and implementation of effective agricultural development programs. Recognition of this fact is growing rapidly within the agricultural research and development community, and a number of projects now actively seek ways to include women in the research and extension process. Incorporation of gender as an analytical variable in the agricultural development equation is becoming a necessity. Achieving this goal requires agricultural professionals to acquire "a new set of conceptual and analytical perspectives and skills in order to deal explicitly, effectively, and efficiently with women-related issues in the spectrum of projects in which they become involved" (Overholt et al. 1985, xii). The materials contained in *Working Together: Gender Analysis in Agriculture, Volumes 1 and 2*, address this need by providing the agricultural community with (1) an efficient framework to analyze gender issues in agricultural systems, (2) a set of seven case studies which allow hands-on experience in dealing with gender analysis in research and extension contexts, and (3) a set of teaching notes to assist trainers or facilitators in using the case studies.

LINKING GENDER TO AGRICULTURAL DEVELOPMENT

The incorporation of gender issues and analysis in agricultural research and extension is a fairly recent phenomena resulting largely from the intersection of two fields of research and practice: farming systems research and extension and women in development.[1] Both grew out of discontent with the inequitable distribution of benefits from the results of technological change in developing countries in the 1950s and 1960s. Both employ interdisciplinary methods joining socioeconomic and technical perspectives and skills. There are, however, significant differences between the two fields, and creating the linkage has not been a smooth process. Nonetheless, the results of the interaction have benefited the theoretical and methodological underpinnings of each.

Farming systems research and extension (FSR/E) is an approach to agricultural research and development that embodies an interdisciplinary, on-farm, client-oriented, participatory systems perspective. Chapter 1 of this volume describes the approach and methodology in greater detail. The approach brought to the attention of agricultural development professionals the importance of the household as the central decision-making unit of the farming system. While the focus on the household was part of a long-needed recognition of the rational decision-making of low-resource farmers in agricultural research and development, it unfortunately also obscured the differences among individuals within the household. Borrowing household models proposed by economists, practitioners assumed that the farm household functioned as a single unit of production and consumption. It was further assumed that consensus among household members existed on the allocation of resources and benefits, and that all household members' interests and problems were identical (Cloud 1988).

In recent years, these beliefs and assumptions about farm households have radically shifted due to the substantial and growing body of empirical research on women's roles in development. Nearly twenty years have passed since Ester Boserup (1970) first challenged the notion that development would automatically improve women's status. In recognizing that women's position relative to men could actually worsen as a result of development as currently practiced, Boserup's work launched the field of research on women in development (WID) around the theme of equity. During the 1970s research on women's economic activities documented and clarified the linkages between equity and the more technical problems of efficiency and productivity. By the early 1980s, awareness had grown around the world and across development sectors that the success of development projects hinged on understanding women's roles in production and including women in the development process. WID researchers focused on women's importance as household producers and providers in addition to their more commonly known domestic and reproductive roles. Evidence mounted that women were active producers whose potential contributions were often overlooked or undermined by development projects, and women were identified as central figures in the low-resource households that were the focus of FSR/E efforts. It was increasingly recognized that technology designed to help one farmer in a household could hurt other farmers in the same household.

By recognizing differences between men's and women's roles in production, the assumed homogeneity of the farm household was replaced by the concept of "intrahousehold dynamics." The recognition that these diverse and complex relationships among members of households must be considered in the design, testing and evaluation of technology has stimulated some of the most exciting and innovative methodological developments in FSR/E to date.

The FSR/E approach and its growing acceptance and institutionalization within agricultural research and extension programs also have fundamentally altered the relationship between social science and agriculture in three key ways that have provided a fertile ground for the incorporation of WID research results and methodologies by: (1) expanding social science involvement from a narrow group of agricultural economists to a broader range of social science disciplines, including anthropology and sociology; (2) enabling social scientists to work as members of teams in the actual development of technology; and (3) developing institutional structures to contain FSR/E thus providing at last a secure home base for the social sciences in agriculture (Bingen and Poats 1990).

These changes have begun to expand the perspective of agricultural development personnel and also, equally important, brought new professionals, many of them with WID expertise, into the agricultural field. Application of WID tools to the iterative procedures of FSR/E is changing the way production problems are identified, the understanding of the division of labor and the nature of farmer participation.

The analysis implied in the above discussion does not involve just understanding what women do, but rather entails an understanding of the cross-culturally variable social roles of men and women. Such analysis requires more than endless checklists of questions or guidelines for data collection and calls for the use of analytical frameworks designed specifically to deal with gender issues (see Overholt et al. 1985 and the conceptual framework in Chapter 1 of this volume). Creation of such frameworks has been part of a shift away from the WID focus on women's equity and involvement to a "gender and development trend...[that]...analyses the nature of women's contribution inside and outside the household...sees women as agents of change rather than as passive recipients of development assistance...question[s] the underlying assumptions of current social, economic and political structures...[and] leads not only to the design of interventions and affirmative action strategies which will ensure that women are better integrated into on-going development efforts...[but]...to a fundamental reexamination of social structures and institutions" (Rathgeber 1988).

The incorporation of such frameworks into the day-to-day way of doing research is intimately linked to training. A major finding by a recent survey of projects using the FSR/E approach was that training is crucial to the effective integration of gender issues and analysis in research decisions (Poats, Gearing, and Russo 1989). While there was a correlation between having women and/or social scientists on teams and whether or not gender analysis was conducted, not all women or social scientists were successful in conducting gender analysis. Their presence did not guarantee attention to gender issues. However, in all cases where training (either formal or informal) in gender issues and analysis occurred, those project members did subsequently conduct or improve gender analysis.

Though the total numbers in the survey were small, this does point to the usefulness of explicitly including training mechanisms in an overall strategy to incorporate gender issues in project activities.

THE GENDER ANALYSIS AND FARMING SYSTEMS CASE STUDIES

The materials in these volumes are the result of a collaboration begun in 1984 between the Population Council, New York City, funded by the Ford Foundation, and the Farming Systems Support Project (FSSP) at the University of Florida, funded by the United States Agency for International Development (USAID). The FSSP was responsible for developing materials for training research and extension workers in FSR/E methods, so it seemed a logical step to enhance this responsibility through a collaborative project that would bring greater WID expertise to bear on this objective. Our advisory committee assisted in deciding to develop case studies as training materials, in framing a request for material which was sent to more than six thousand FSR/E practitioners, development workers, and WID researchers around the world, and in the final selection of cases to be written. All of the case study authors were or are still members of the agricultural research and extension teams featured in the studies. The cases are true accounts of the selected projects offering a view into the workings, decisions, plans, and results of an interdisciplinary agricultural development effort. Prior to writing the cases, the authors were trained at a workshop in case study writing and in the use of the conceptual framework. Since then the cases have been extensively tested and refined and teaching notes to the cases found in Volume 2 have been developed.

Working Together will assist practitioners in learning and using gender analysis. Volume 1 contains the case materials. A conceptual framework and worksheets for gender analysis in on-farm research or other agricultural development activities is contained in Chapter 1. The case method describes the process of looking at a body of material and analyzing it alone and with colleagues. A description of the method and guidelines for preparing a case are included in Chapter 2. The remaining chapters in this volume are case studies based on field research in Botswana, Burkina Faso, Colombia, Indonesia, Kenya, Philippines, and Zambia. Volume 2 includes analysis and teaching notes for each of the cases in Volume 1 and material describing subsequent research and experimentation in all the cases.[2] The teaching notes include a proposed set of pedagogical or learning objectives and sets of questions which can be used to guide individual study and group discussion. These notes are for trainers or for others wishing to use the materials for self-study. The notes are not meant to provide right answers to the cases, but rather to guide users, especially those who have not had previous experience in teaching with the case method.

Our overarching objective in producing these cases is not to argue for a new specialty or discipline. Rather it is to encourage, through the use of case studies, the integration of gender analysis into the mind, heart and soul of agricultural research. With practice, gender analysis will become an integral part of the diagnostic and analytic tool kit, the pragmatic day-to-day way of doing good research and development work in agriculture.

NOTES

1. The discussion in this section draws heavily upon the information and analysis contained in three earlier papers: Poats, Schmink, and Spring (1988); Poats, Gearing, and Russo (1989); and Rathgeber (1989). We particularly acknowledge the lucid presentation by Rathgeber on tracing the history, similarities, and differences between women in development, women and development, and gender and development.

2. The cases were written in several parts so that they would unfold over time similar to the actual unfolding of farming systems research. Because the later parts to each case report what a team of researchers actually did, they might bias the open examination of alternatives desirable in case study discussions. Therefore, except for the Colombia and Kenya cases, Parts 2 and 3 to each case (where there is one) have been published in *Working Together* Volume 2.

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Chapter 1

Conceptual Framework for Gender Analysis in Farming Systems Research and Extension

HILARY SIMS FELDSTEIN AND SUSAN V. POATS
WITH KATHLEEN CLOUD AND ROSALIE HUISINGA NOREM

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Appendix 1 Worksheets for Gender Analysis

INTRODUCTION

The purpose of this conceptual framework is to revise the bias of gender which underlies much current agricultural research and extension. In planning for and implementing agricultural development projects, the household is generally taken as the unit of analysis and male heads of household as the principal decision makers and sources of information. The roles of household members other than the male head of household are frequently ignored. This is to the detriment of the project and those it is meant to serve. Adult women, senior men and women, and children bring specific skills, resources, and priorities to farm production. To ignore them is to ignore half or more of the system in which decisions about farming are made.

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The conceptual framework presented here provides guidelines by which information on gender roles and the intra- and interhousehold aspects of farming systems may be gathered, analyzed, and applied to the design of improved technologies for agricultural and livestock systems. Such new technologies are intended to increase yields, improve consumption, reduce risk, stabilize the environment, or otherwise strengthen farm production possibilities. The framework highlights the information necessary to describe a farming system and the process by which female and male farmers are included in the research and extension activities of a given area. It provides a means by which practitioners can organize and analyze data for use in planning subsequent stages of a project.

In agricultural research or projects using a farming systems research and extension (FSR/E) approach, agroclimatic, biological, and socioeconomic data provide scientists with the tools for identifying problems and opportunities and for considering the technical possibilities of new and improved technologies. Socioeconomic data is included from the start and enables scientists to understand farmers' decision making and intentionality (Jiggins and Fresco 1984), that is, what resources they can bring to bear and their interest in mobilizing those resources for a particular enterprise, especially if new or modified (McKee 1985). Together, the technical and social science data are necessary for pinpointing areas of research which will meet client needs (Chambers and Jiggins 1986). In most societies, gender roles and intra- (within) and inter- (between) household relations profoundly affect farmer decision making. The dynamics within and between households are based on differences of gender, age and seniority or position in the household. They are also profoundly affected by class and ethnicity (Alice Carloni, letter to the authors, 1985; Schulman and Garrett 1984) and developmental stages in the life cycle (Guyer 1980; McMillan 1984).

There are two basic arguments underlying this framework. The first is that *differences between men's and women's roles and patterns of intra- and interhousehold relations are embedded in farming systems and will have an effect on and be affected by changes in these systems.* We know that in every society women and men do different things, have access to different resources and benefits, and have different responsibilities. For example, women and men may be responsible for different crops, for different fields of the same crop, for different tasks in the production cycle (Cloud 1985, 1988). These differences are rooted in social organization and are supported by cultural beliefs and values. We also know that, in many cases, despite the persistence of beliefs about what people do or should do, these roles are in flux.

Recognition that male or female responsibility for production and reproduction tasks in farming systems vary from one society, race, class or ethnic group to another has encouraged the understanding that such activities are socially or gender defined, not sexually determined. As a social construct, gender roles are mutable and responsive to other changes in the

farming system. In agricultural research, the researcher's task is to observe and record these gender related differences in behavior and use these data as part of the analysis leading to the design and testing of improved technologies. Such knowledge will contribute to improved research. Experimental modifications will be targeted towards better understood production constraints and opportunities and farmer and user preferences.

The second argument is that *FSR/E is an iterative and collaborative process, one which explicitly calls for continuous assessment and redesign.* It is not linear, there are overlapping cycles of activity: diagnosis, planning and design, experimentation and evaluation, and recommendation proceed simultaneously. Each activity encompasses many decisions which are based on information learned from previous activities. This means there must be a continuous flow of knowledge, including, most importantly, the views of the farmers (women and men) whose system(s) will be affected. Because participation and continuous evaluation and adaptation are key, the framework for gender analysis takes into account *how knowledge is gathered and used and who is involved* throughout the project.

This framework is based on the premise that productivity and efficiency are enhanced when technological improvements are developed and targeted towards the actual users, that is, those making decisions or actually engaged in the tasks at issue and those responsible for the use of the final products. This requires knowing who does what and whose resources must be mobilized.

Issues of equity are also addressed by using this framework. There is an explicit concern for the welfare of families and individuals within families. Implicit is the knowledge that with improvements in welfare, particularly better nutrition and a better distributed or less crushing work load, there will also be increases in productivity. The "maps" or profiles created by the framework provide the means for pinpointing the distribution of the costs and benefits of particular changes. Taken together, they will help predict whether the frequently cited goal of improvements in welfare are likely to be forthcoming or whether there may be negative consequences. Tradeoffs will be explicit. Farmers, product users, researchers, and policy makers all have preferred outcomes. This framework provides one tool for assessing proposed activities against these different sets of preferences. Finally, an improved understanding of the roles and resources of all members of a household means that those formerly overlooked will be recognized and their needs and productive opportunities can be addressed by agricultural research and extension efforts.

GENDER ANALYSIS, INTRA- AND INTERHOUSEHOLD DYNAMICS: WHAT ARE THEY?

Gender analysis has become the commonly accepted term for analyzing gender roles and intra- and interhousehold dynamics within farming systems and applying that analysis to decisions about agricultural research

and development activities. That households can be disaggregated in several ways—by age, status, gender—can complicate the methods for identifying constraints and problems of farmers. Of these, gender has proved to be the most useful category to disaggregate the farm household and analyze intrahousehold behavior (Cloud 1988). It is also a point of entry into understanding intrahousehold relations and decision making and to recognizing where interhousehold relationships have an important bearing on farmer decisions and activities. This access to the low-resource farm household contributes to more efficient and more equitable technology development and delivery.

Gender analysis begins with the recognition that the household is not an undifferentiated grouping of people with a common production and consumption function, that is, with shared and equal access to resources for and benefits from production. Rather, households are themselves systems of resources allocation (Guyer 1980). The pattern of decision making varies from one place or culture to another. In some places, households fit the standard model of a single decision maker or benevolent dictator. In other areas, household decisions are shared, consultation takes place between particular members or all members. In some areas, households are hardly units in any sense of the word. Men and women and children have wholly separate spheres of decision making affecting production, income and expenditures. And in other places, the degree of participation of some household members in enterprises controlled by others results from internal bargaining (Jones 1984). Thus, within a given system, individual household members may share some goals, benefits and resources, be independent on some, and be in conflict on others. In short, the form of the household and patterns of decision making cannot be assumed. What we face is complexity, not homogeneity. In a particular farming system or a single enterprise within that system, even where the household is a useful unit of analysis, the pattern of activities, resources and incentives of its members are important information and must be determined by investigation.

A detailed inquiry into patterns of decision making or intrahousehold dynamics is rarely possible as part of an agricultural research and extension project. The purpose of this conceptual framework is to provide categories for inquiry and analysis which help agricultural researchers identify *relevant information* on who does what and the factors underlying farmers' decisions.

There are several ways of looking at intrahousehold characteristics such as the roles, resources, and incentives of individuals within and between households. First, members are seen as *belonging to a category of individuals* defined by gender, age, position, or seniority: for example, women and men, adults and children, senior wives and junior wives, relatives and nonrelatives. Such categories frequently carry with them combinations of rights and responsibilities, defined by law or expectation, which govern individuals' farming activities as much or more than their

membership in a household unit. For instance—men prepare land, women weed; women raise swine, men raise cattle; women grow cassava, men grow maize; senior wives work on their own fields, junior wives on those of their husbands and the head of household. Gender analysis focuses on differences in the activities, resources, and benefits of different members within the household and on patterns of obligation, cooperation or conflict between household members.

Second, within a community there may be *different kinds of household structures* which emerge as responses to stages in the life cycle, population movements, or differences in asset holding, residence, or cultural traditions. Different household structures may have different resources and face different incentives. For instance, households with young children may give priority to adequate food crops and the demands for women's labor; households with older children at home and more labor upon which to draw may take on more labor demanding activities. Temporary or permanent migration may leave a high proportion of female-headed households with less available labor and more limited access to resources for production. This variation in type (or interhousehold differences) may be as important as ecological differences for designating appropriate research or recommendation domains.[1]

When looking at the roles of individuals or household structures, it is important to keep in mind that roles and resources are influenced strongly by economic class, especially between smallholders, large landholders and the landless. All women are not the same. While there may be community-wide agreement on women's roles—e.g. "women weed"—women in well-to-do households may not weed because women from poor households are hired to do so.

Third, individuals or households may belong to *other corporate groupings* (neighborhood, kinship group, church). These relationships carry with them patterns of access to resources, and obligations which affect decisions about agricultural production. It is this patterning which is referred to by the term "interhousehold." Poor rural households often depend on labor exchanges, exchanges of goods, cooperative activities, and other alliances for survival. "Interhousehold dynamics" refers to such patterns of exchange or dependency of individuals or households with other entities.

We therefore include in gender analysis alternative ways in which one looks further than the household to understand how resources and incentives are organized and might be mobilized for changes in farm production.

FARMING SYSTEMS RESEARCH AND EXTENSION (FSR/E)

FSR/E is an approach used in agricultural research and extension to generate appropriate technology for specific clients, most commonly low-input or resource-poor farmers. The FSR/E approach is holistic and itera-

tive, and embodies conceptual and methodological tools to complement existing national agricultural research and extension systems by making them more efficient. FSR/E improves efficiency and effectiveness because it brings research and extension workers together in interdisciplinary teams to work with production systems, not with isolated crop or livestock commodities or thematic issues. Farms are viewed as systems with interconnected subsystems. Research teams consider the potential impact of a new technology on the whole farming system because a positive benefit to one subsystem may have a negative impact on linked subsystems. This systems perspective minimizes the potential cost of producing and implementing technologies which provide narrow, short-term solutions, yet cause other more difficult problems.

Many different terms and definitions exist for the numerous local variations of farming systems activities, and several ways to categorize these have been proposed (Merrill-Sands 1986; Simmonds 1985; Bellon et al. 1985; Hildebrand and Waugh 1983). A useful approach is to consider farming systems efforts as divided into two large categories (Norman and Collinson 1985; Poats et al. 1986). The first comprises those efforts to alter or change the entire production system of an area, such as a large-scale irrigation project or the introduction of a completely new farming system using state-of-the-art technology. It is characterized by the term "farming systems in the large." The second category, which is most commonly called FSR/E, includes those efforts operating in a step-by-step, iterative fashion within the existing production system and recognizes that the "content and scale of these steps must necessarily be compatible with farmer resources, their risk ceilings, and their management capabilities" (Norman and Collinson 1985). This category can be subdivided further into those projects which define their focus for research based on the diagnosis of the whole production system of the target area, and those that enter the system with a predetermined focus on an enterprise or commodity. The terms "in the small" and "with a predetermined focus" characterize these two separate but methodologically related applications of the farming systems perspective.

FSR/E embraces a wide array of local and national variations in procedures and applications. However, most practitioners agree that the common elements underlying the various versions include: an explicit focus on resource-poor clients, a commitment to farmer participation in the development of technology designed to meet their needs (Ewell 1988), the use of an interdisciplinary systems perspective, the integration of on-farm and on-station experimentation in the design and testing of new or alternate technologies, collaboration between research, extension and development entities in on-farm research, and a focus on the farm family or household.

Tying together these common elements is a methodological strategy that progressively associates farms and farmers within appropriate prob-

lem-focused domains defined by environment, ecology, social criteria, and the nature of a particular problem shared by farmers. Domains are not static but shift as farming systems are better characterized through the process of on-farm research.

The FSR/E approach is currently applied to technology development in crops, livestock, and agroforestry. Most practitioners agree that FSR/E has four distinct stages (Poats et al. 1986). The four overlapping activities —diagnosis, planning and design, experimentation and evaluation, and recommendations to farmers, researchers, and policy makers—are described in more detail in the next section. Each of these stages may be identified by slightly different names, depending on where it is practiced; some stages may be subdivided and may vary in length of time depending on the results of the previous stage. They may also occur cyclically or simultaneously, depending on the nature of the research program; in most cases they are continuous activities (Galt 1985).

In some instances, the process may begin with on-farm trials to facilitate the diagnosis of certain problems. In others, work may be at a diagnostic stage in one community and at a testing stage in another. Or, both may occur simultaneously in the same area when different problems are being addressed among the same farmer group. One farmer may be grouped with others into one domain for one identified problem and into another for a different problem. Ongoing farmer feedback and evaluation are emphasized at each step in the adaptive research process allowing "time to learn about the intricacies of farming systems and to incorporate new insights into more refined measures and project adaptations" (Poats et al. 1988, 5).

This process-oriented iterative approach of FSR/E and its focus on farmers and farm households opened a crack in the heretofore closed arena of agricultural research and development for the introduction of gender issues and analysis.

GENDER ANALYSIS AND FSR/E ACTIVITIES

The initial diagnosis of a farming system will provide an approximation of the factors influencing farmer decision making. Continued testing and refinement of biological interventions through on-farm testing will benefit from being accompanied by continued and more focused collecting of data on gender roles and other socioeconomic factors. As well as organizing what is known, this conceptual framework helps define what additional information is needed. During each activity, the information collected and the use of that information will differ, but cumulatively they refine what is known about a farming system or enterprise and what innovations will best meet farmers' needs.

Diagnosis. The collection and analysis of information about a farming system is used to characterize the farming systems and constraints, to delineate research or recommendation domains, and to identify problems and opportunities for improvement. It lays the groundwork for on-farm research. *Diagnosis is an ongoing process throughout FSR/E* as additional agronomic and socioeconomic information is collected and used to refine knowledge of the farming system. Information is collected by means of formal and informal surveys, time allocation or labor studies, meetings with farmers and users, etc. Gender-sensitive information includes *(a)* the demographics of different types of households and other groupings which are important to the investment in and labor for farm production and *(b)* the activities, resources, and incentives or preferences of different (categories of) household members.

Planning and design. Planning and design involve the determination of which technologies might be tested with what anticipated results, what further agronomic or socioeconomic research is required, and the actual design of on-station and researcher- or farmer-managed on-farm trials. The problems identified during the diagnosis are examined as to their causes, the need for further diagnostic research, and possible solutions (Tripp 1989). As constraints or problems are clarified, potential solutions are screened according to their availability and their compatibility with the farming system. This process is called *ex ante* analysis. For well-defined problems, this involves a determination of whether there is available technology (off-the-shelf) or a need for on-station experimentation. It is at this stage that proposed experiments should be examined with respect to *(a)* their fit for all the farmers in the area or for particular groups, *(b)* the desirable characteristics of all end uses of the output of production from the point of view of all users, and *(c)* assumptions about the availability of particular resources, including labor, necessary for using the new technology (Carloni 1982).

Trial design includes specification of the experimental variables, treatments and levels; number, location, size, and form of experimental plots; selection of farmer cooperators; and protocols for the establishment and monitoring of on-farm trials. Researchers should describe the manner of involving those whose way of doing particular tasks are being changed. The lack of data for making some of these decisions may make apparent a useful set of questions or observations to parallel the on-farm and on-station testing.

That women may be responsible for separate fields, separate crops or livestock, or separate production tasks calls for more careful determination of who does what in the system and who has a problem. That the farmer involved in the task affected by a problem must be involved in the on-farm research to solve that problem calls for greater involvement of women as trial collaborators.

Testing and evaluation. The actual implementation, data gathering, and ongoing evaluation related to on-farm and on-station trials is accompanied by continuing diagnostic research on questions raised during the initial diagnostic and planning phases and by observations which verify or expand survey information. It is during this stage that gender roles and intra- and interhousehold dynamics will become better defined by means of in-depth or focused surveys, field observations, and informal conversation. Discussions during on-farm trials provide an opportunity for getting at the more subtle aspects of decision making and tradeoffs made or contemplated with respect to specific new technologies. All individuals involved with the production and use aspects of an experimental technology are valuable sources of information. The evaluation of the first set of trials and an increased perception of gender implications becomes the basis for a better targeted second set of trials.

Recommendations to farmers, researchers, and policy makers. The agronomic and socioeconomic information from the experimental stages are analyzed with appropriate recommendations to farmers, researchers, and policy makers. Testing and evaluation will reveal technologies which work and those which don't or need further refinement. These results, positive or negative, need to be communicated to the relevant decision makers. Where technologies are not yet proven useful, data from the trials and complementary research can be helpful in redefining the research problem or adjusting trial design. Where technologies are ready for wider dissemination, the availability of and means for gaining access to inputs, including information, needs to be stated explicitly. Likewise recommendations for policies to correct for unequal access to resources need to be explicit about means as well as intent.

USE OF THE CONCEPTUAL FRAMEWORK

Many people seeing gender and intra- and interhousehold issues addressed for the first time may feel overwhelmed and have visions of exhaustive data collection. The framework is aimed at *selectively* identifying and organizing the information for gender analysis which will contribute directly to FSR/E in a particular location and in light of a project's objectives. The framework is flexible and may be used to describe a whole farming system or a particular enterprise (FSR/E with a predetermined focus), and the worksheets described below may be used together or individually. With the worksheets, maps or profiles are created against which technological solutions may be examined for improved *ex ante* analysis, on-farm trials and evaluation, and the organization of extension. Use of this approach will make research more efficient (quicker, better

targeted) in specifying desirable characteristics of new varieties and technologies, in screening for the compatibility of proposed changes with existing practices and incentives, in recognizing for which farmers the experimentation may be useful, and in identifying the tradeoffs of alternative solutions.

THE FRAMEWORK

There are four areas in farming systems research and extension where gender analysis can make an important contribution. These areas of analysis are (1) *labor or activities*, (2) *resources*, (3) *benefits and incentives*, and (4) *inclusion*.[2] The first three build the descriptions of farming systems. Inclusion analysis makes visible the process by which FSR/E projects collaborate with farmers, that is, *who* is included and *how* farmers are included in each activity of the project. Each area of analysis is described below and a worksheet for each area is provided in Appendix 1.

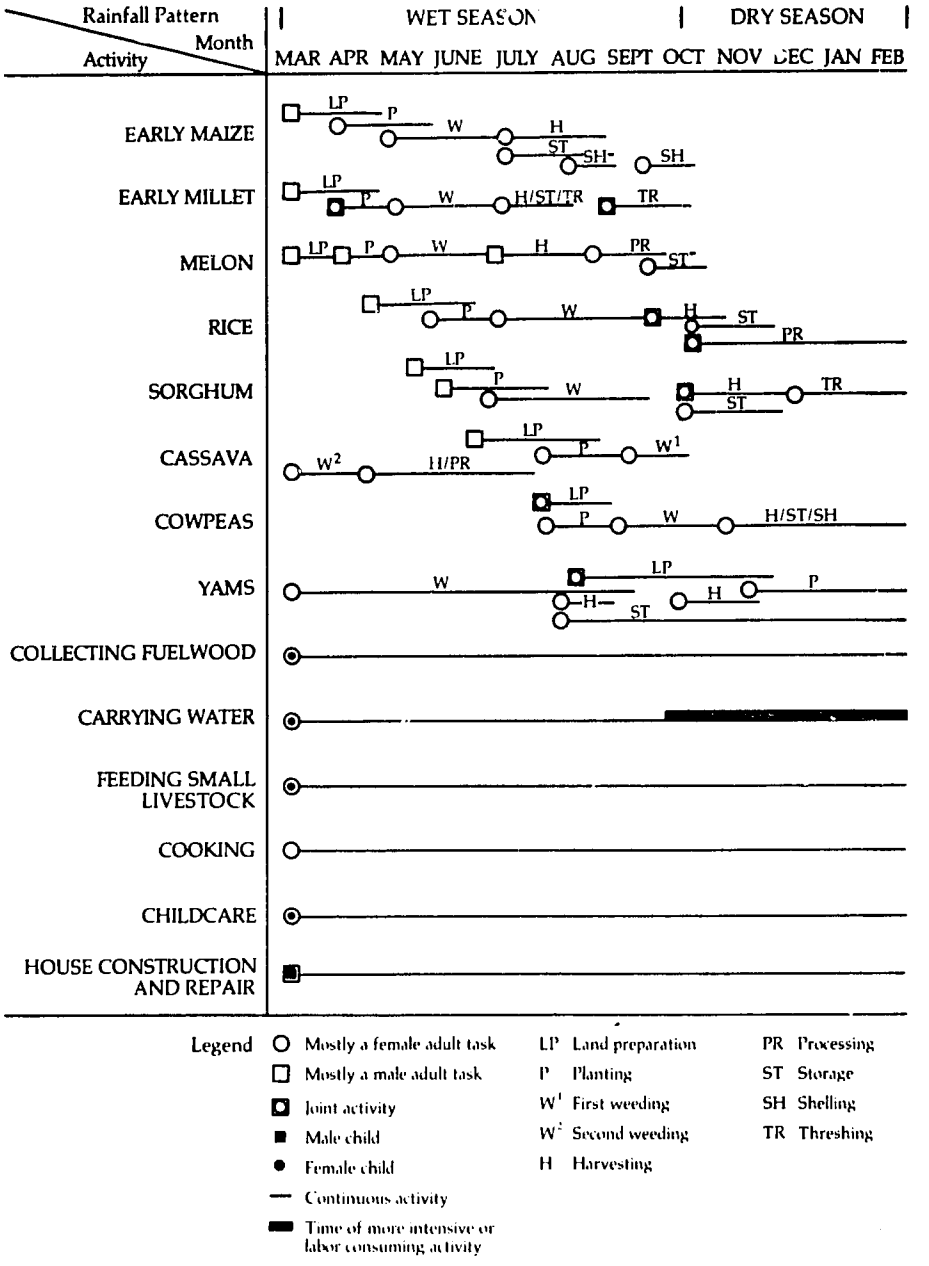
Activities Analysis

In this section we are concerned with *who does what*, particularly as this relates to the agricultural year and other seasonal patterns. Production difficulties are frequently traced to labor shortages usually at particular times of the year and often for particular tasks. Therefore we need to know *what tasks* are undertaken by men, women, and children which contribute to farm production, to household production (for self-provisioning or sale), to child bearing and rearing, and to other productive enterprises including off-farm activities.

Worksheets 1-1 and 1-2 provide a format for analyzing activities by season and gender. In Worksheet 1-1, "Farming Systems Calendar," the primary agricultural and other tasks are laid out according to the agricultural calendar. For each month, the tasks associated with all production are listed. In addition to agricultural and livestock production, tasks associated with household production and with other activities which contribute to family and individual welfare, whether in cash or kind, should be included. Once the tasks are listed, gender roles can be marked by symbols or colors. A sample calendar is illustrated in Figure 1-1. In Worksheet 1-2, "Activities Analysis," who does what task is designated by gender, age, or other factors. In some cases, whole areas of activity will be segregated by gender; for example, men—cattle, women—crops. In others, sequenced tasks related to the same enterprise may be assigned by gender; for example, men—land preparation, women—weeding (Cloud 1985).

Once the information is entered, Worksheet 1-1, the seasonal calendar, reveals periods of labor shortage and identifies all the competing tasks by gender, not just those in farm production. Worksheet 1-2, activi-

Figure 1-1
Example of a Gender-disaggregated Activities Calendar



Source: Based on Mary E. Burfisher and Nadine R. Horenstein. 1985. *Sex Roles in the Nigerian Tiv Farm Household.* Women's Roles and Gender Differences in Development: Cases for Planners, no. 2. West Hartford, Conn.: Kumarian Press

ties analysis, indicates who does what. Whose labor will be affected by proposed changes? What are the competing demands? Who needs to be taught new methods? Use of the two worksheets, separately or together, create an *activities map* or profile with which to screen the identification of problems, the selection of research priorities, the designation of collaborating farmers, and the design of on-farm trials. In cases where the use of labor or the timing of operations are not affected by proposed changes, activities analysis without the calendar may be sufficient.

Resources Analysis

Farm management decisions are influenced or determined by the availability of and control of or access to resources or inputs. Worksheet 1-3, "Resources Analysis," provides an outline for disaggregating by gender and age who has access to and control of critical resources. By *control*, we mean the power to decide whether and how a resource is used, how it is to be allocated. By *access*, we mean the freedom or permission to use the resource, perhaps with some decision making once access is obtained. Some examples will illustrate this. Where men have control of livestock for traction, their wives and female relatives may obtain traction services from them. Women have access to traction, but men have control of it. Where women keep the cash and make decisions about expenditures, women have control of cash, men have access to it.

The question of access to and control of land can be confusing, but is also illustrative. For instance, in the case where land is allocated by a senior male, but decisions about what to plant are left to the person to whom it is allocated, one would note that both adult males and adult females have access to land (with some indication that female access is through males); and that both have control of land, but that male control is greater (allocation and decision making on use) than female control (decision making on use only). The greater control of senior males than junior males would also be marked.

Resources include land (and the terms on which it is available); capital, including cash, tools, and livestock for production or traction; labor (one's own, family/children's, others'); other inputs, including seed, fertilizers, and pesticides; services such as credit and education; and knowledge. If inputs are purchased, who has the cash to purchase them? If made available to farm operations through local exchanges, to whom and from whom do they come? If inputs are produced on-farm, such as manure or mulch material, who controls or has access to them? *Knowledge* is a particularly valuable and often overlooked resource. It includes the results of years of farmer history and experimentation, a practical knowledge of soil variability, traditional risk-reducing strategies, and seed qualities. Such knowledge is often associated with task and is important for

understanding current use of resources and for screening proposed changes. Resources also include access to markets which in turn may be influenced by mobility or membership regulations. While a distinction has been drawn between labor and nonlabor resources, it is important to look for instances where the use of one provides access to the other, such as giving of labor in exchange for use of land or traction animals.

Access and control analysis creates another screen or map for looking at production constraints and proposed solutions. What are the available resources? What resources are required for proposed changes? Who controls them? To whom and how will new resources be made available? Or whose resource shortage is relieved? Does the control or noncontrol of key resources suggest separate research domains?

Benefits and Incentives Analysis

Acceptance of and benefits from a new technology depend ultimately on farmer and user preferences or intentionality. It is important to understand what motivates people's decisions about the allocation of labor and other resources to farm production, home production, or other activities. This depends largely on who benefits from and the intended use of the output of each enterprise.

Benefits analysis refers specifically to who has access to or control of the output of production. This includes *all the end uses* of a product (for example, of a crop: home consumption, sale, income from sale, fodder, compost, crafts, building materials, etc.). It also includes the output of *alternative or competing enterprises*, such as areas which are currently wild or fallow but which may be the source of important medicinal or food items, and the output of other resource-using or time-consuming enterprises, on- or off-farm, which may compete with farm production. Benefits may also occur through changes in the farming system, such as reduced labor demands or reduced risk.

Incentive analysis goes one step further. Associated with each output or product are user preferences which underlie farmer incentives to continue or change what they do. Incentives may be associated with the production characteristics of an enterprise, such as particular plant characteristics, increases in yields or income, stabilization of yields or the environment, reduction of risk, timing of operations, or reduced labor demands. They also may be associated with the uses of the output, such as prestige, obligations to family or other groups, taste, marketability, improved nutrition, processing characteristics, or availability of fuel, fodder, and building materials.

Worksheet 1.4, "Benefits and Incentives Analysis," is for creating a map or profile disaggregated by gender and age of the incentives and benefits associated with agricultural and other production. This map di-

rects attention to the desirable characteristics of new plant material or other new technologies. What should be added or retained in a new variety? What characteristics may be lost and what substitutes found? It is a mechanism for screening whether proposed changes in activities or resource use by particular (categories of) individuals fit with changes in either the type or receiver of benefits. Are those who bear the additional costs the beneficiaries? It is a guide to the incentives (or lack thereof) for changing present allocations.

Laying out the distribution of *activities, resources, and benefits/incentives* between household members as they relate to farm production and alternative activities is the initial task of gender analysis. It provides a skeletal understanding of intrahousehold decision making. It may not reveal much about the level of communication and shared information. It does not reveal the actual process of negotiation within the household concerning the pooling or complementarity of resource allocation, or the subtler pressures which affect individual and household choices. It does provide a means for framing questions about the effects of proposed solutions at the household level. What reallocation of labor and resources does the proposed solution require? Who is affected? What are the possible tradeoffs? From such analysis, what is learned and predictable is used in screening proposed solutions for compatibility and for fine tuning the design of on-farm trials. What is still questionable or unpredictable indicates critical areas for further monitoring, observation, and focused discussions with farmers and users.

Inclusion Analysis

Inclusion analysis deals specifically with technique, with the methodology for FSR/E. Farmers are central to FSR/E. To understand a farming system and the practices connected with any specific enterprise, all significant participants—those who do the work, those who invest their resources, those who use the products—are valuable sources of information. Inclusion analysis asks who is included at each stage or in each activity connected with farming systems research and extension. A further level of analysis on inclusion would ask:

1. What type of inclusion? How are women and men included in the categories or kinds of information gathered, as sources of information, and as actors (implementors), decision makers, and beneficiaries? Whose interests or preferences are represented at each stage?

2. What are the criteria for including particular individuals? Is the selection random or purposeful? If selection is nonrandom, what is the rationale? *Criteria for selecting farmers* often contain uncon-

scious sources of bias such as proximity to the road, identification by the village head, or membership in an organization which is restricted to male heads of household (Sutherland 1986). Sometimes the person who actually does the task is overlooked in confining collaboration to the household head. Selection of farmer cooperators has been identified as the "chronically weak link" in on-farm experimentation (Ewell 1988). The need to make explicit the rationale behind purposeful selection should make more evident where gender is an important variable.

3. What steps are taken to encourage inclusion? The *mechanisms* or methodology for collaborating with farmers will also influence participation and the richness of farmer response. Important considerations include time and frequency of visits or meetings, location, rules and means of access, whether joint, individual, or group interviews, focus of the questions asked, amount of flexibility or open-endedness, attitude of the researchers, and, often, gender of the researchers. Attention to criteria and mechanisms applies equally to organizing the extension of promising technologies and the supply of any new inputs. Merely stating there is "open access" does not guarantee full participation or response.

Worksheet 1-5, "Inclusion Analysis: FRS/E Activities," is a matrix for looking at who and how women and men farmers and product users are included in the full range of activities encompassed by the FSR/E approach. Inclusion analysis using Worksheet 1-5 creates a profile of research and extension activities for evaluating sources of information and farmer response. It is useful for planning and monitoring research and other activities. For instance, if farmer response to a new technology or participation in experiments is weak, an analysis of the process of including farmers may provide clues to improved research and extension practices. Does the criteria for the selection of participants include all or exclude any significant persons? If certain groups are not included because they lacked necessary resources, are there other, more appropriate technologies which could be tested for this group? Are the mechanisms or methodologies employed ones which make participation comfortable for all parties?

APPLICATION OF GENDER ANALYSIS TO ON-FARM EXPERIMENTATION

As indicated in the discussion above, gender analysis provides a framework of information for considering the consequences of decisions about research or recommendation domains, researchable problems, the design

of on-farm trials, and extension. This means screening each possibility for its gender implications. At the center of the farming systems approach is on-farm experimentation, working with farmer collaborators to evaluate promising solutions to their problems. A detailed discussion of this application is found in Poats and Feldstein (1989). Worksheet 1-6 highlights the main points and provides a framework for applying gender analysis to an on-farm trial. For each aspect of the design and implementation, what are the gender implications? What are the explicit, gender-related features of the design? Why or why not is gender taken into account? If gender is not pertinent, make this assumption or finding explicit.

CONCLUSION

The application of the analysis suggested by this conceptual framework will help protect research from gross errors of inefficiency or inequity in outcomes. It offsets the prevailing bias toward concepts of a unitary household and male heads of household as sole decision makers and sources of information. It provides the rationale and means for understanding gender roles and intrahousehold dynamics as they affect farm production, and it will contribute to improved planning of on-farm research and extension.

NOTES

1. A research or recommendation domain is the grouping or targeting of farmers for whom a particular or series of proposed technologies is likely to be appropriate. The term "research domain" is a newer term. It generally refers to the initial broader grouping and reflects readily identified agroecological and socioeconomic critiera. "Recommendation domain" has been used for this broader grouping, and, more recently, is being used to recognize subgroups that are identified after solutions have been tested in light of farmer response to the experiments and refined understanding of agroecological and socioeconomic differences within the original research area. Both research and recommendation domains may be discontinuous reflecting the on-the-ground presence of variability. For a more detailed discussion, see Wotowiec et al. (1988).

2. The framework presented here builds substantially on pioneer work in conceptualizing gender roles and developing the gender analysis framework by Catherine A. Overholt, Mary B. Anderson, Kathleen Cloud, and James E. Austin (1985).

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Appendix 1: Worksheets for Gender Analysis

Worksheets 1-1 and 1-2

Farming Systems Calendar and Activities Analysis

EXAMPLES

Crop production: food crops, cash crops, trees, home gardens, gathering of wild foods, medicines; land preparation, processing, storage, transport, marketing

Livestock: cattle, small ruminants, poultry, draft animals; hunting

Household production: food preparation, child bearing and rearing, fuel, water, building maintenance; beer brewing, craft production, snack food production

Off-farm activities: wage labor, marketing, sales, schooling

GENERAL QUESTIONS FOR STAGES OF FSR/E

(a) *Diagnostic:* What are the activities (task and time allocation) of members of the household by gender and age which contribute to agricultural and livestock production? What are the interactions associated with gender-related segregation or sequencing of tasks? When are these tasks undertaken? How much time is involved? Does this vary with age or rank or position in the household? or by economic class of the household? Does the physical location of the task for women with small children or cultural limits on the mobility of women influence whether or not a woman may carry out a task? What time is allocated to other remunerative or obligatory activities, including household production (for sale or trade) and off-farm enterprises or wage labor? What time is allocated for household maintenance and family welfare including child care, food preparation, fuel and water supply, building maintenance, etc.? Is there interhousehold labor mobilization, whether by individuals or groups, as for work parties? Is availability of labor for particular activities a constraint on production?

(b) *Planning and design:* What changes in labor allocation (time required, timing) are associated with or are desirable from technological improvements being tested? Whose labor is affected? Will there be increases or decreases in wage or exchange labor requirements and who will be affected?

(c) *Testing and evaluation:* What changes in labor allocation, in time or task, are actually associated with on-farm experiments? Do these contribute to or detract from increases in productivity or income or decreases in risk for this enterprise? or for other enterprises or activities of the household? Do they fit what was predicted in the design?

(d) *Recommendations to farmers, researchers, and policy makers:* Have the changes in labor allocation (time and/or task, location, sex or age of the doer) related to the new technology been taken into account in assessing its success or in further adaptations? Is the new information required in using this technology being directed to those who are doing the work?

Worksheet 1-1

Farming Systems Calendar

Months												
Seasons												
Crop Production												
Livestock												
Household Production												
Off-farm activities												

Worksheet 1-2

Activities Analysis

	Males[a]	Females[a]
Crop production		
Crop/Field 1		
Task 1		
Task 2		
Task 3		
Crop/Field 2		
Task 1		
Task 2		
Task 3		
Crop/Field 3		
Livestock		
Animal 1		
Task 1		
Task 2		
Task 3		
Household Production		
Off-farm production		

[a]Or other important categories (ethnic, class, age, position, etc.)

Worksheet 1-3

Resources Analysis

EXAMPLES

Capital goods: livestock for production, for draft; poultry, farm equipment, food, storage facilities, fencing, trees

Inputs: seeds and seedlings, fertilizer, manure, fodder, insecticides

Knowledge: seed selection criteria, planting techniques, marker plants for soil fertility

Education: general, specialized courses

GENERAL QUESTIONS FOR STAGES OF FSR/E

(a) *Diagnostic:* What are the resources required for existing production practices? Who (men, women, children, position in household, or which households) have access to and/or control of these resources? Is access affected by exchange relationships? Is the absence of particular resources a constraint on current production? Is it a constraint for particular categories of farmers? To what extent are income and expenditure streams for men and women separate or joint? What are the income and expenditure streams for men and women including sources, uses, and timing?

(b) *Planning and design:* What changes in kind or amount of resources will be required by each of the technological improvements being tested? Who has access to or control over these resources? Are technologies being tested which address resource gaps of particular categories of people? Will the value of factors of production be affected by proposed changes?

(c) *Testing and evaluation:* How and to whom have new resources been supplied? Who has/has not used them? What networks of relationships or exchange have been used to obtain any additional resources needed? Can further constraints in access to resources by particular groups be identified as a result of the testing?

(d) *Recommendations to farmer, researchers, and policy makers:* Has the access or control of resources necessary to the acceptance of new technologies been taken into account in determining its success? Are new or modified systems required to insure access to (new) resources for particular categories of farmers?

Worksheet 1-3
Resources Analysis

	Access	Control	Notes	Implications for FSR/E
Land				
Who uses				
How to use				
Water				
Labor				
Own				
Family				
Hired				
Capital goods				
Inputs				
Purchased				
Produced on farm				
Cash				
Agricultural credit				
Knowledge				
Markets/Transportation				
Education				

Worksheet 1-4

Benefits and Incentives Analysis

EXAMPLES

Crop production: maize—cobs, stalks; cowpeas—grain (peas), leaves, stems; *Leucaena leucocephala*—fuelwood, timber, shade, mulch, fodder, soil enrichment; medicinal herbs

Livestock: cattle—meat, milk, manure, draft

Home production: leather goods, beer, snack foods, baskets

GENERAL QUESTIONS FOR STAGES OF FSR/E

(a) *Diagnostic:* Who (gender, age, position in household) benefits from the output of current production of each enterprise in terms of subsistence, income from sales, or other uses? What and under whose control are the important subsistence crops, particularly for periods of stress? Are there obligations associated with the output of particular production enterprises? Are processed farm products a source of income? What are the desirable improvements from the point of view of men, women, and children? What nonagricultural enterprises are a source of income or other benefits to household members and how do they compare (profitability, reliability, seasonality) with farm production enterprises?

(b) *Planning and design:* Do the changes in technology have the characteristics desired by farmers and users? Do they eliminate any desired or useful characteristics? Will the technological improvements lead to changes in the uses of the product and thus in the nature or locus of benefits? Will there be changes in the characteristics of the product which will affect its use pattern? What are the incentives for men, for women, or for those higher or lower in seniority to contribute additional time or resources necessary for improvements? or to change varieties or practices? What tradeoffs may have to be made?

(c) *Testing and evaluation:* What incentives or disincentives are actually associated with the particular modifications being tested as indicated by observation or answers to questions? Are there incentives or disincentives associated with being a cooperating farmer? How do the technologies being tested affect individual income streams? How do users respond to any changes in product? Are postharvest users of products involved in testing?

(d) *Recommendations to farmers, researchers, and policy makers:* Has a shift in use of resources resulted in a shift of beneficiaries? Are increased labor demands for a particular enterprise matched by increased benefits for the individuals supplying the labor? Where there are increases in production are there outlets through increased consumption, adequate storage, or markets? Are these outlets equally accessible for all farmers?

Worksheet 1-4

Benefits and Incentives Analysis

	Access	Control	Uses/Characteristics[a]	Implications for FSR/E
Crop production				
Livestock				
Household production				
Off-farm enterprises				

[a]Uses and desirable characteristics of product including uses of all parts of the plant or animal:

a. consumption
b. storage for later consumption, exchange, or sale
c. other domestic use (e.g. fuel, building material)
d. exchange
e. sale
f. reinvestment in agricultural production (e.g. manure)
g. other

Worksheet 1-5

Inclusion Analysis: FSR/E Activities

EXAMPLES

Who is included?

What type of inclusion: interviewed, as consultant, as interviewer or enumerator, as decision maker, as cooperator, as beneficiary

Why included: criteria, rationale

How included: frequency of contact, location, rules and means of access, methodology for gathering information (formal and informal surveys, group meetings, focus groups, forced field analysis, observation, farm and household records)

GENERAL QUESTIONS FOR STAGES OF FSR/E

(a) *Diagnosis:* Are women as well as men included in formal or informal interviewing in each household and in the community at large? Are there any cultural or structural barriers to interviewing certain categories of people and are appropriate efforts being made to reduce those barriers? Are government or nongovernment services which have field workers with particular access to women (e.g. home economics, community development, primary health centers) included in the collecting of information during initial and subsequent surveys or in identifying areas of concern?

(b) *Planning and design:* Are women and men farmers as well as women and men professional researchers included in determining research priorities and in the design of on-farm research? Are all categories of farmers for whom the technology might be useful represented among the collaborating farmers? Are designs explicit on how the views of all household members are to be included in assessing new technologies and on-farm trials? Are special efforts made to get the views of hard-to-reach farmers (such as women with small children or any whose mobility is otherwise limited)?

(c) *Testing and evaluation:* Are women as well as men included as cooperating farmers in on-farm research? for particular enterprises? in fields? in the management of trials? in interviews evaluating the trials? Are there factors which inhibit the participation of particular categories of farmers?

(d) *Recommendations to farmers, researchers, and policy makers:* Will the targeting and means used for dissemination encourage participation from all farmers? Will steps be taken to overcome barriers of some groups to receive information on new practices or is having access to new resources required?

Worksheet 1-5

Inclusion Analysis: FSR/E Activities

Stages of FSR/E	Who is Included	Criteria for Inclusion	Mechanisms of Inclusion
Diagnosis			
Planning and design			
Experimentation and evaluation			
Recommendations			
To researchers			
To policy makers			
To extension			
Extension			
Information			
Inputs			
Credit			
Market outlets			

Worksheet 1-6

Application of Gender Analysis to On-farm Trials

EXAMPLES

Trial objectives: Trial objectives reflect preferences of both men and women farmers who cultivate the same crop, or, if management practices and preferences are too different, appropriate trials are designed for each.

Treatments: Experimental varieties of maize include desirable fodder qualities of stalks (women's criteria) as well as grain yield (men's criteria). Controls include both men's and women's cultivars if different.

Trial design: Experimental plot size and configuration take into account women's traditional planting patterns unless these are the experimental variables.

Selection of cooperators: Farmer cooperators include proportionate representation of female-headed households where those are a significant percentage of farm population. Where it is not culturally acceptable for male trials assistants to work with individual women farmers, work is done with women's groups or a female trials assistant is hired.

Trial operations: In a fertilizer application trial, women and small boys, who are responsible for this task, are consulted about traditional practice and trained in new practices. Women are trained in experimental spacing to increase plant density and regularity.

Data to be collected: The labor and resource use data are collected in a disaggregated format.

Evaluation: Men and women farmers and product users have been interviewed throughout the trial and in the final evaluation of results.

GENERAL QUESTIONS FOR DIFFERENT TYPES OF TRIALS

(a) *Varieties or species trials:* If men and women have different management practices for the same crop, are trials put on both men's and women's fields? Is the effect of a shorter season variety on labor patterns being monitored during the trial? Have postharvest uses been considered in specifying desirable characteristics and have these users been included in the evaluation?

(b) *Cultural practices* (such as spacing, timing, sequencing, pruning, weeding, land and water management): Are those who do a specific task involved in determining feasibility and in learning how to do a new or changed task? If different operations are affected, is the data appropriately disaggregated? If alternative uses of labor are different for men and women, are different opportunity costs being applied to the economic evaluation?

(c) *Plant and animal nutrition and protection* (use of fertilizers and pesticides, building or growing of fences, bird scaring, etc.): Who has control of the local products or cash needed for new inputs? Is their resource use being monitored? Do the experimental levels of input use cover the range of resource constraints? If separately owned crops are on one field, do the trials or practices to protect one crop, such as the use of herbicides, include the monitoring of the effect on associated crops?

Worksheet 1-6

Application of Gender Analysis to On-farm Trials

	Gender Implications	
	What?	Why?
Trial objectives		
Problems being addressed		
Treatments Levels Controls Evaluation criteria		
Trial design Random block, etc.? Number and location of farms? Number of replications/farm?		
Selection of cooperators Who selects? Criteria? Who are they?		
Trial operators What are they? Who is trained? Who implements?		
Observations and data to be collected		
Complementary research		
Evaluation		

Chapter 2

Introduction to the Case Method

HILARY SIMS FELDSTEIN AND SUSAN V. POATS

CONTENTS

Why Use a Case Method?
Guidelines for Using a Case in a Workshop
Suggestions to the Reader for Preparing a Case

WHY USE A CASE METHOD?

Teaching cases styled after those of the Harvard Business School are used for training business management students in analysis and decision making with respect to everything from factory design and financial management to marketing. This kind of case study is distinctly different from descriptive or analytical cases which describe, analyze, and reach conclusions about a particular project or set of events.

A *teaching case* describes a set of events and provides available, relevant data, but leaves analysis and conclusions to those who read it. Thus the material presented in each case consists of description and data, including often the opinions of different actors. Each case is a slice of reality, covering a short amount of time, and using only data which was available to decision makers when they were planning next steps.

Case studies are a form of experiential learning. Because people tend to work in ways which are familiar, learned in their disciplinary training or cultural milieu, the integration of gender analysis into people's way of doing research requires thinking in new ways. Old assumptions and conceptions must be replaced or rearranged; the process of analyzing data and working through decisions must be changed. For many, case studies teach them a new way of thinking.

Teaching-type cases are about analysis and decision making. These are behavioral skills, not easily taught by lecture or essays. The objective

of using teaching cases (the case method) is to put practitioners in a near-to-life situation where they are faced with analyzing the data at hand and making decisions about next steps. By first undertaking gender analysis using the available data from the cases in this volume and then discussing relevant decisions at the next stage of research and extension, people begin to experience how gender analysis helps them make decisions which will result in more efficient research and equitable distribution of its benefits.

The point of discussion generated by analysis of cases is not to arrive at a predetermined answer. In fact, there are no right or wrong answers. Rather, the purpose is to illustrate and practice using analytical concepts and to allow participants to compare their conclusions with those of other participants. It is a highly participatory method. Using the case method, one gets practice in analysis and decision making with familiar and relevant material, a hands-on experience that can be applied to one's own research or development responsibilities.

The FSR/E approach to agricultural research and development involves many steps and decisions. As research and extension activities are organized each season or year, planning incorporates information and analysis from the previous year's work. The analytic concepts to be practiced with these farming systems cases is gender analysis. The cases are accompanied by a conceptual framework and worksheets for gender analysis (Chap. 1). Tandem use of the framework and the cases enhances the understanding that the analytical questions are the same but the answers and thus the actions are different. Participants learn that there is no one recipe for including gender in every development situation.

The case studies presented in this volume provide information about particular farming systems, the resources available to the researchers and project decision makers, and the context within which decisions are to be made. Reflecting the interdisciplinarity of FSR/E, the information is drawn from the social and technical sciences. The data available to project members on gender is included in descriptive and tabular form. This is the raw material. Applying gender analysis to the material provides practitioners and students with a realistic exercise in analysis and decision making in FSR/E. At the end of each case is a set of study questions to guide the reader in analyzing the case.

To some extent, the data available in the cases has been synthesized and simplified, to make it manageable within the confines of a training situation. However, its incompleteness also reflects reality; in any project or ongoing activity, decisions have to be made with the data available. These are not always an ideal set.

The most important aspect of case method teaching is that it actively engages the participants in dealing with subject matter. Wider training and human resource development experience has shown that adults learn new

material better when they actively use it and apply it to situations relevant to their own work. This engagement is crucial for integration of the issues into the mainstream of agricultural research and development work.

GUIDELINES FOR USING A CASE IN A WORKSHOP[1]

1. For each of the sessions a case will be assigned to be read by all participants and prepared for discussion and analysis. Discussion will take place first in small groups and then in a plenary session. The primary objective of this exercise is to allow participants to exercise their analytical skills in a workshop environment by dealing selectively and intensively with aspects of gender roles and other intrahousehold processes as they relate to agricultural research and development activities.

2. Case study analysis, as a learning process, requires the concentrated involvement of participants. The method is highly participatory. What participants get out of it will depend, more than anything else, on what they can put into it. Participants will need to read and analyze the case, arrive at a justifiable conclusion, discuss their conclusions with other participants, and then objectively review their conclusions.

3. The purpose of a case study is *not* to arrive at predetermined proven solutions. Rather it is to illustrate analytical concepts and allow participants to compare their conclusions with those of other participants.

4. The study questions at the end of each case and the conceptual framework and worksheets set out in Chapter 1 will be useful in analyzing the case.

5. Three common criticisms of case studies are *(a)* the information provided is insufficient (which is inevitable without the insights gained from first-hand experience) and, therefore, it is impossible to make an adequate analysis of the material; *(b)* the case is a snapshot taken at a point in time while, in reality, all field situations are fluid; and *(c)* a case will lack reality in that the participants are called on—and indeed required—to make decisions which they do not have the responsibility for implementing. Readers should find it helpful to be aware of the above.

SUGGESTIONS TO THE READER FOR PREPARING A CASE

1. People approach the task in different ways, but for newcomers to the case method, the following might prove a useful basis from which to start.

a) Read through the case very quickly to answer these questions:
What is the case talking about?
What kinds of information am I being given to analyze?

b) Read carefully through the case marking all the key facts as you go and develop an outline on scratch paper of the major areas of the case and their interactions.

c) *Put yourself in the decision-making position* and reexamine the important information, making sure you have a grasp of the problems, their causes, and possible alternative courses of action.

d) Develop your recommendations in a form in which you can present and argue them.

Working with cases is intensive and you will find that you need to have a grasp of a lot of information on each case, and also that you have to move rapidly from one to another. Where several cases are used, material from earlier cases may be used in later sessions. Clear but concise notes from your readings will be helpful.

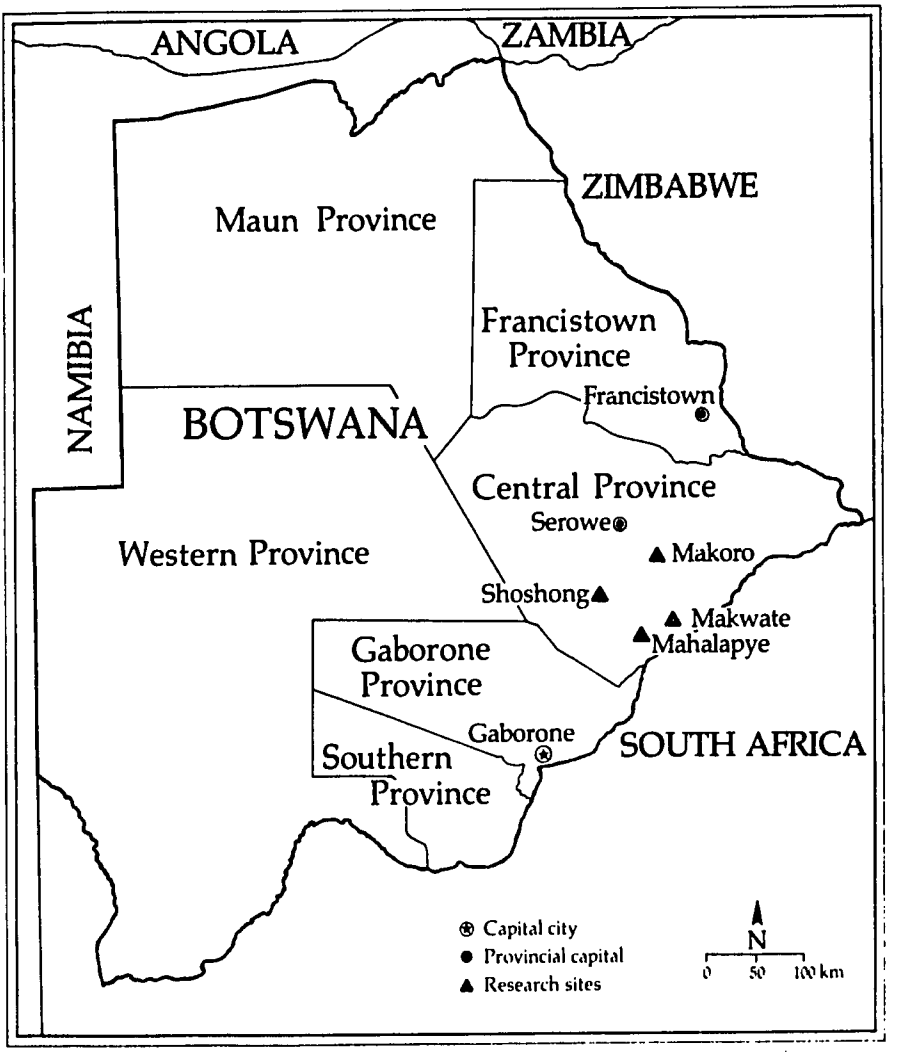
2. After your individual reading, you will meet with your study group, present your arguments to the members of the group, and hear theirs. This testing of your analysis and recommendations is an important preparatory step for the discussion in the plenary sessions, and provides you with an opportunity to reexamine and evaluate your earlier conclusions in the light of the insight of others.

3. In the plenary sessions, while the trainers will provide a structure for the case discussions, it is their role to prod you to explore fully the avenues of investigation and lead you into consideration of areas you may have missed. Finally, the trainers will summarize the discussions and draw out the useful lessons and observations which are inherent in the case problem and which emerge from the discussions.

NOTE

1. These notes have been adapted from those prepared for the case studies workshops in the Gender Project on Women in Development, 1984, directed by Dr. Catherine Overholt at the Harvard Institute for International Development and under contract to the United States Agency for International Development.

Figure 3-1
Map of Botswana Showing the Research Sites
for the Central Region Farming Systems Team



Chapter 3

Botswana

Farming Systems Research in a Drought Prone Environment, Central Region Farming Systems Research Project

DOYLE C. BAKER WITH HILARY SIMS FELDSTEIN

CONTENTS

Part 1 First Three Seasons of Research
Project Background
CRT Activities, 1982–85
Selected Findings
Dean's Reflections
Study Questions
Notes

Appendix 3-A Agricultural Programs in Botswana
Appendix 3-B Selected Research Activities, First Three Years
Appendix 3-C Experimentation and Outcomes, First Three Years

Part 2 Adaptations in Experimentation and Monitoring during the Fourth Season (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

Botswana: Part 1
First Three Seasons of Research

Dean Curtis sat in the small thatch-covered building that served as the office of the Central Region farming systems team. Dean, the agricultural economist for the Central Region team (CRT) since its creation three years earlier, was feeling discouraged. Every season, drought had led to few successful trials and the team had yet to identify any promising interventions. Dean was reviewing the summary report he had prepared for the review team which was to meet with the CRT the next day.[1]

DEAN'S REPORT

PROJECT BACKGROUND

National Development Profile

Since independence in 1966, Botswana has become one of the richest countries in Africa deriving income principally from sale of beef to the European Economic Community at high producer prices and from the discovery of large-scale mineral wealth. Livestock dominate both the traditional and very small freehold agricultural sectors, contributing more than 70 percent of the agricultural value added. The rapid growth of mineral revenues has led to an international balance of trade surplus and a government budgetary surplus. Major strides have been made in providing rural infrastructure and services.

During the late 1970s, an undercurrent of concern emerged about the pattern of development. Many rural households had no cattle and could not benefit from the new cattle prices. A tremendous expansion of the national herd during the 1970s led to increased rangeland degradation. Meanwhile, land and labor productivity in agriculture remained low and the nation's annual requirements for food grains (100,000–120,000 tons) far outstripped national production of 50,000 tons. Food imports cost U.S. $10 million annually in the early 1980s.

Despite its declining contribution to national income, a viable agricultural sector still is considered necessary to generate employment opportu-

	BOTSWANA
Area	582,000 km^2.
Population	1 million.
Income	GDP/capita: 1966—U.S. $90, 1981—U.S. $550. Sources: before 1966—livestock, remittances from mine laborers; after 1966—beef to European Economic Community; minerals.
Vegetation	Two-thirds desert and semidesert.
Elevation	Average 1,000 m; maximum 1,500 m.
Rainfall	600 mm in northeast to 250 mm in southwest. Rainy season: late October to March. Often late; high frequency of prolonged dry spells; high local variability.
Currency	Pula. 1 Pula = 100 thebe. 1 Pula = U.S. $0.75 (1983).
	CENTRAL REGION—MAHALAPYE
Area	147,730 km^2.
Population	6,800 farms.
Rainfall	Average 450 mm; erratic pattern.
Soils	Low porosity; susceptible to capping; hard when dry. Usually sandy loams; organic matter and phosphorus content low.
Temperature	December–January: 31° C; May–June: 0–5° C.
Land	Cultivated holdings: less than 3 ha, 40%; 3.1–6 ha, 30%. More than 6 ha, 30%. Inheritance predominantly male.
Income	Major sources are livestock and off-farm employment.
Crops	Sorghum (89%), maize (85%), millet (2%), beans including cowpeas (72%), melons.

nities, reduce dependency on food imports, and reduce household dependency on government resource transfers. Current estimates are that 30 percent of rural households are dependent on food assistance and cash for work programs. Over 80 percent of rural households are involved in agricultural production. To stimulate agricultural development and improve food security, the Ministry of Agriculture has initiated a wide range of research, extension and resource transfer programs. (See Appendix 3-A.)

Traditional Farming in the Central Region

Most of the population in the Central Region is scattered among small villages where water, schools, clinics, and trading stores are located. Characteristically, household members are often spread across several residences. This dispersion is necessary to take advantage of income earning opportunities. Most households have a primary village residence and a lands area, located within a day's walk from a village, where arable production activities are concentrated. If a household has cattle, usually one

or more members are located at a cattle post. Depending on the life cycle of a family, there generally is also one or more members living in a town or urban area with (or seeking) wage employment.

Farming in the traditional sector is based on communally held land. Both men and women can obtain land allocations or receive land through inheritance. Farmers without land allocations usually are able to borrow land at no cost. The area cultivated per farm averages four to five hectares, although the land controlled often is two to three times the area cultivated.

Cattle generally graze freely near the cattle posts. Lactating cows are penned part of the time for milking, and calves are penned for the first several months of their lives. General herding is done only occasionally. Since there are few permanent water sources, livestock are usually watered at bore holes or open wells during the dry season.

Crop production takes place primarily in the rainy or summer season, between late October and June. Sorghum is by far the most important crop; sorghum mixtures account for much of the area planted. During the summer, small amounts of maize, cowpeas, and jugo beans, and various types of melons, watermelons, and sweet sorghums are grown by most households for their own consumption.

Total production of each of the major food crops is extremely low. Even in a good year, total food grain production is under 50 kilograms per person, based on average grain yields of 150–200 kilograms per hectare. Crop production is susceptible to low and unreliable rains, and during drought years average national production generally falls to only 20 kilograms of sorghum and 3 kilograms of cowpeas per hectare.

Cropping practices are quite similar throughout the traditional sector. Nearly all land is mechanically plowed. Traditionally, men do the plowing and women plant; in the case of sorghum, women broadcast the seed while land is being plowed. Most draft power is provided by cattle, usually teams of six to eight oxen, but tractors and donkey traction are rapidly becoming important sources. A majority of farms rely on their own traction power;[2] other farms either hire traction or obtain it through family help or various forms of resource exchanges or sharing agreements.

Control of traction can affect the earliness of plowing during the season and the timeliness of plowing vis-à-vis rains. Planting early in the season is a long-time extension recommendation and refers to initiating plowing and planting after the first or second rains in early November. Some farmers agree with this strategy, but most prefer to plant after the second or third rains—at the end of November or early December—for a variety of reasons. Livestock are often in poor condition after a long, dry season with little fodder. To improve weed control, farmers prefer plowing after weeds germinate. All farmers agree that January is too late to start unless it is unavoidable.

After a rain there is rapid evaporation and drying of the soil. Farmers consider the optimum time for plowing and planting to be during the first one to five days after a rain. Thereafter the soils are harder to plow and seed germination is poor unless there is another rain soon. Traction owners are reluctant to use or lend for use their oxen and traction equipment when "the soil is too dry." They give priority to their own plowing and often will allow their oxen to be used by other farmers only late in the season.

Objectives of the Central Region Team

The Central Region Team (CRT) was established in 1982. The team was directed to focus on crop production and the crop-livestock interface in order to improve production by resource-poor farmers in such a manner as to contribute to equity and national food independence. The CRT was also given an institutional mandate to identify promising on-farm research methods for continuing use by the Ministry of Agriculture.

The target group of farmers was defined to be those cultivating from one to ten hectares and having less than thirty-five head of cattle. This group encompassed more than half the households in the project zone and comprised forty percent female-headed households. Thus, women were expected to be among the primary beneficiaries. Moreover, since women are responsible for most of the crop farming in Botswana, it was assumed that they would directly benefit from most interventions to increase productivity even in male-headed households.

CRT ACTIVITIES, 1982–85

The CRT has pursued an ambitious research program and made many adjustments during the first three seasons in an attempt to identify relevant development strategies and production technologies.

Initiation of On-farm Research

The CRT was formed only a month before the rains began at the end of October 1982. The CRT's initial objective was to identify leverage points[3] upon which to begin experimentation. By December, the team had reviewed secondary information, selected research villages, carried out village exploratory surveys, set tentative research domains, and selected cooperating farmers.

Review of secondary literature. From the review of the secondary literature, two key problem areas affecting the priorities for farming systems research were identified. First, research both on- and off-station had shown that no interventions were likely to have a large and consistent impact on agricultural productivity. Past research did suggest that the plowing and planting operation was a leverage point since modifications in other practices would not be worthwhile until farmers had adequate plant populations in their fields. Existing research indicated levels of fifty thousand plants per hectare to be beneficial.

The secondary literature indicated that timely access to draft was the most important factor affecting plowing and planting possibilities. Other major factors were the health and training of traction animals, availability of water at the lands area, and the condition of plows and harnesses. Other constraints to agricultural productivity were weed competition, insect pests (stalkborers on sorghum and flower-eating beetles on cowpeas), head smut (the primary sorghum disease), the short traditional length of the work day, bird damage, and cattle and wildlife damage.

Several studies identified a second key problem: the importance of female-headed households. Most research showed that these households were generally poor, lacking access to draft and male labor. The team was undecided whether they should be treated as a separate unit of analysis or whether they were more appropriately treated with respect to access to draft resources or the presence of male labor. Other questions related to the complexity of farm household linkages in Botswana included how to treat income from nonresident household members, and how to treat the arrangements between households for draft power. The researchers were aware that among the Batswana there were multiple arrangements for access to draft.

Because of the uncertainties and conflicting views over the value of research on these questions, the team initially agreed on a long-term approach to experimentation and monitoring. This long-term approach resulted in a two-track research program. The agronomists carried out an experimental program focused on plowing and planting operations; the agricultural economists carried out subject surveys and resource monitoring activities in order to do a whole system diagnosis.

Village selection. The two research sites are Shoshong East in Mahalapye West District and Makwate, in Mahalapye East District. Shoshong East represents the dominant pattern of cattle and tractor farming and is a large village of 321 households (36 percent female headed) with several active village groups, trading establishments and schools. Makwate represents donkey traction-based farming. It has 116 households (41 percent female headed) and has fewer services and less infrastructural development. Selection of the sites was followed by exploratory surveys with multidisciplinary teams who talked with all household members.

During the farm interviews, farmers generally complained about rainfall, livestock damage to crops, and lack of resources. Few of the husbandry issues identified by the teams were raised by the farmers. Farmers did acknowledge they had problems with plant stands, weeds, insect pests, etc., when these issues were raised by the CRT. The team confirmed that, on many of the farms, the women did most of the work. Several units had a husband, father, or son working elsewhere who returned to help with plowing. In less than one-fifth of the households did any of the household men help with weeding.

Definition of research domains. Six tentative research domains were defined based on access to (control of or dependent) and type of traction (tractor, oxen, or donkeys). Draft control included owners and those with long-term borrowing arrangements which gave them effective control over the amount and timing of plowing. Access to draft by the household was hypothesized to be a critical factor affecting its ability to implement timely planting operations and multiple tillages. Type of traction used was considered to be important because of differences in the speed and quality of plowing and planting operations, and expense.

Farmer selection. The team decided that their farmer cooperators should accurately reflect the different categories of farmers in the villages. To establish a sample frame for proportional (or stratified) sampling, the team administered a sixteen-question census to all the households in Shoshong East and Makwate. The census included key variables required for stratifying households into research domains (access to and type of traction) and for capturing other criteria for disaggregation, particularly wealth and sex of head of household, which might be important in whole system diagnosis.

Using the sample frame, fifty-two cooperator farmers were selected; twenty-seven for resource-use monitoring and twenty-five to implement trials. The trials farmers were stratified according to the six research domains. In order to ensure adequate numbers of female and poorer households for system diagnosis, the resource-monitoring sample was subdivided according to two other important characteristics: (1) male- or female-headed households, and (2) poor (0–15 cattle) or rich (15+ cattle).

Resource Monitoring and Special Studies

The resource-monitoring study covered household assets, labor use, and resource flows into and out of sample households. Single-visit subject surveys were undertaken on topics such as interhousehold exchanges and draft arrangements. Technical monitoring was carried out on plots of

farmers to identify the main technical determinants of cropping outcomes. Several additional technical studies were carried out covering topics such as soil variability and weed burdens. Characteristics of selected studies from the first three seasons are covered in Appendix 3-B.

Experimentation

During the first three seasons, the emphasis in experimentation was on alternatives to the traditional system of sorghum production—broadcasting seed and plowing it in with a moldboard plow—in order to get improved plant stand, plant vigor, and yield. In planning the experimentation, several hypotheses were discussed. One was that the traditional broadcast system performs as well as any alternative and that, instead of new practices or implements, the key is the timing vis-à-vis the rains. Another hypothesis was that row planting and multiple tillage systems have much higher potential than the traditional systems.

Because of the conflicting hypotheses, the experimentation program started a few trials designed to compare several recommended plowing and planting systems with the traditional system. After the first two seasons, the sorghum production plowing and planting research focused on the most promising alternatives, row planting and double plowing (early plowing, followed after at least one rain by a combined broadcasting seed and plowing operation).

After the first year, some nonleverage interventions were investigated each season. These were studied because there were relatively few clear results coming from the plowing and planting work because of the ongoing drought. The team felt that minor interventions might lead to increased agricultural employment and improved equity even though they make a small contribution to national production (food independence) goals. Nonleverage trials included sole planting of crops other than sorghum, and varietal comparisons between traditional cowpeas and research station varieties of cowpeas, mung beans, and other legumes. Other trials covered postestablishment practices such as filling gaps (replanting, transplanting) where there was poor germination, or thinning overcrowded areas.

During the first two seasons, the primary format for experimentation was researcher-managed and farmer-implemented trials (RMFI). A traditional check plot was nearly always included as a treatment. In addition to the formal trials, the team also undertook some exploratory, informal investigations that depended on subjective farmer and researcher evaluation of interventions. In a few cases, researcher implemented treatments were superimposed on farmers' plots.

At the beginning of the third season, the approach to experimentation changed significantly in three ways. First, there was a change in the

strategy for selecting trial participants. It had become apparent that households lacking control of traction could not implement multiple tillage operations. Therefore, only those households which could be expected to implement the multiple tillage systems (i.e. draft-controlling households) were now included in the tillage research.

Second, there was a change in the targeting of interventions. The initial traction-based research domains were found to have little relationship to a farmer's interest in multiple tillage (as opposed to the capability of doing multiple tillage) and essentially no significance for nontillage interventions. Therefore, during the third season, the team experimentally began to define relevant populations for each intervention being tested. The definitions of relevant populations encompass a wide range of factors, including soil types, farmer interest or activity level, implement ownership, and even who within a household is responsible for particular decisions. The revised approach to selecting trials participants and targeting interventions and the relationship of this approach to the use and definition of research domains is the focus of lively discussion among team members.

A third major change in the experimentation program has been an increased emphasis given to researcher-managed and researcher-implemented (RMRI) design trials. Because of problems with farmer implementation and inadequate progress on the technical evaluation of different plowing and planting practices, the agronomists feel more formal experiment station-type trials are justified. The RMRI trials conducted with farmers capable of multiple tillage operations and becoming commercial producers are "steps-in-technology" trials. They are designed to provide a factorial (treatment by environment) evaluation of plowing and planting and phosphate in sorghum production and recommended treatment and environment interactions. The trials included subsoiling and the addition of phosphate fertilizer as factors along with the plowing and planting experiments.

Dean pulled out a folder with a description of all the research conducted to date by the CRT. They had engaged in so many investigations that a complete summary of results would be overwhelming for the review team. Selected findings which most influenced the thinking of the team would be useful. Because the type of traction used by farmers shifted so much during the three seasons, results were reported for the several sets of categories—draft controlling and draft dependent, rich and poor, and male- and female-headed household—that he had used for the resource-monitoring activities. This preliminary breakdown would help the CRT and the review team decide which categories might be most useful for further research activities.

SELECTED FINDINGS

Farm and Household Management

Household resources. The crop management survey done in Shoshong East and Makwate (116 households) revealed the distribution of key characteristics as follows:

1. Sixty-two percent control and 38 percent dependent with respect to draft for plowing

2. Fifty-two percent poor (0–15 cattle) and 48 percent rich (15+ cattle)

3. Sixty percent male- and 40 percent female-headed household

The demographic structures of households and the value of farm assets are reported in Table 3-1. The main implement owned by most households was a single moldboard plow, and a majority of plows were more than ten years old. Across household types, 25 percent of the household members regarded farming as their main activity.

The patterns of labor activity by age and sex in fieldwork, other income activity and household maintenance are reported in Table 3-2. The amount and distribution of hours spent on different fieldwork activities greatly depended on the rainfall during the season. In the drought seasons observed, there did not appear to be any specific labor constraint period. When asked which was the hardest month, the general pattern of response was January (24 percent), February (18 percent), and June (18 percent). When asked what was the main work during the hardest month, the answers were weeding (74 percent), harvesting (41 percent), and bird scaring (22 percent).

Nonhousehold labor accounts for nearly one-quarter of all fieldwork, but there were no cases observed of cooperative work groups for post-planting operations. Most nonhousehold labor comes from relatives or through hiring traction. Households exchange labor for a variety of tasks, especially livestock tending, fencing and destumping, bird scaring and harvesting, and plowing (aside from that obtained in conjunction with traction). Interhousehold resource exchanges also take place with traction, seed, land, and crop and livestock products.

Crop production. Most farmers grow sorghum (89 percent) and maize (85 percent), a few grow millet (27 percent), and 72 percent grow

Table 3-1
Comparison of Different Types of Households

	Sex of Head		*Cattle Assets*		*Draft Access*[a]		
	M	F	0–35	>35	C	D	All
Number of households	17	10	16	11	17	10	27
FHH	0	10	8	2	2	8	10
Household composition							
Local residents	9.5	10.7	10.6	8.8	9.9	9.9	9.9
Percent by age-sex[b]							
Men	24	21	21	25	24	21	23
Women	20	23	17	21	20	23	21
Boys	29	21	23	31	29	20	26
Girls	27	35	35	23	27	36	31
Value of farm assets (P)	11,187	6,866	4,803	16,024	11,212	7,193	9,514
Percent distribution[b]							
Livestock	70	40	47	68	68	49	62
Cattle	(63)	(34)	(36)	(63)	(61)	(43)	(55)
Goats	(4)	(5)	(6)	(3)	(3)	(5)	(4)
Poultry	(1)	(1)	(1)	(0)	(1)	(1)	(1)
Donkeys	(2)	(1)	(4)	(1)	(2)	(0)	(2)
Other	(1)	(0)	(1)	(1)	(1)	(0)	(1)
Agricultural capital[c]	4	10	13	3	5	9	6
Buildings[d]	25	49	40	29	27	42	32

Source: 1983–84 Multi-Visit Resource Use and Plot Monitoring Surveys, 27 households.
Key: FHH = female-headed household; P = Pula.
[a]C = control, D = dependent. Draft control includes farmers doing some or all of their plowing with owned animals and those with borrowing arrangements which give them effective control over the amount and timing of plowing.
[b]Errors due to rounding; numbers in parentheses are percentages for specific categories within Livestock.
[c]Plows, other equipment, handtools, and receptacles.
[d]In lands area and village.

beans, including cowpeas. Cropping practices are quite similar throughout the project area though there is variation. For example, half of the households plant on the first rain of the season, but the others always wait. Several households plant some varieties of crops individually while others intercrop all crops. Crops such as melons and jugo beans are more important than was originally recognized by either the research or extension service.

Most farmers follow a minimal input approach to crop farming. Despite extension efforts, dating more than thirty years, to encourage farmers to row plant, nearly all crops are broadcast and most seed is planted in mixtures. Very few farmers use fertilizers, either manure or chemical, but use of both is an extension recommendation. Few farmers weed more than once and many farmers do not do a single weeding unless a sufficiently promising plant stand is achieved. Multiple weedings, as a means of improved soil cultivation as much as for reducing weed burdens, is a

Table 3-2

Labor Use by Age-Sex Categories, 1983–84

	Men	Women	Boys	Girls
	— Avg. Hours per Household —			
Fieldwork by activity				
Plow and/or plant	48	20	61	1
Weed	12	40	6	6
Harvest	11	103	4	11
Thresh	1	47	1	4
Field maintenance	103	32	26	2
Subtotal[a]	175	242	98	24
Fieldwork by month				
November	21	7	15	0
December	45	16	33	3
January	30	36	19	3
February	4	15	2	3
March	5	9	2	< 1
April	7	15	3	3
May	6	44	2	3
June	8	75	4	8
July	9	21	6	1
August	20	1	10	0
September	17	3	1	0
October	4	1	1	0
Other income				
Tend livestock	468	72	732	18
Milk livestock	18	7	46	1
Make beer	1	98	< 1	1
Sell beer	< 1	159	1	< 1
Wage employment	261	154	25	19
Subtotal	749	490	804	39
Household maintenance[b]				
Gather firewood	37	77	45	29
Fetch water	55	306	48	122
Cook	3	895	24	175
Wash	3	197	10	23
Construct and repair	11	57	5	3
Subtotal	109	1,532	131	352
Total	1,033	2,265	1,033	415

Source: 1983–84 Multi-Visit Resource Use Monitoring Survey, 27 households.

[a]Does not include any hours for bird scaring. Days spent bird scaring were men, 6; women, 38; boys, 3; girls, 9. Around 8 hr/day are spent bird scaring but much of the time is inactive.

[b]Does not include child rearing which is a main activity of girls.

long-standing extension recommendation. Farmer constraints and practices for different household types are reported in Table 3-3.

One of the issues that emerged in the early investigations was under what soil moisture conditions farmers would do plowing. During the second season, a study of whole-farm cultivation activities surveyed thirty-eight farmers. Soil moisture conditions were divided into four categories: (1) before November 15; (2) November 16 to December 15; (3) December 16 to January 15; and (4) January 16 to February 15. Categories three and

Table 3-3

Crop Production Characteristics

	Sex of Head		*Cattle Assets*		*Draft Access*[a]		
	M	F	0–15	>16	C	D	All
Number of households	69	47	61	55	65	51	116
Female-headed households	0	47	34	13	19	26	47
	Percent Responses						
Household members active in cropping							
1–2	41	53	45	47	41	53	46
3–4	37	30	30	35	41	26	34
> 4	22	18	21	18	19	22	20
Major resource constraints[b]							
Lack of cash for seed, transport, traction	29	52	55	20	33	46	39
Too little labor	28	15	15	31	26	18	23
No or inadequate fencing	25	17	12	33	25	18	22
Other[c]	19	14	19	16	17	18	17
Primary access to draft							
No plowing done	7	15	16	4	0	24	10
Own, borrow, manage	67	40	46	67	100	0	55
Hire, coop. arrangement	26	44	38	29	0	76	34
Have done the following							
Plant on first rain	68	32	49	58	71	31	53
Early plow without plant	14	0	2	16	14	2	9
Early plow and plant	52	21	3[illegible]	42	60	14	10
Row plant	13	4	8	11	14	4	10
Hand-hoe plant	23	32	33	20	25	29	27
Multiple weedings	29	34	38	24	35	25	31
Have hired							
Labor	37	19	13	49	30	30	30
Traction	41	64	56	53	31	84	54
Transport	26	37	25	36	17	48	30

Source: 1983 Crop Management Survey, Shoshong and Makwate, Random Sample; 116 households.

[a]C = control, D = dependent.

[b]Respondents were asked to identify their first- and second-most important resource constraints out of a list of six.

[c]Too little or bad equipment, too few or weak traction animals, too little or poor land.

four are less than ideal for plowing and planting. For both traction-controlling and traction-dependent households, over one-third of the area plowed and over two-fifths of the time spent plowing and planting was during these periods, under conditions of less-than-ideal soil moisture.

The returns to fieldwork, traction, and management are very low. Cropping outcomes differ significantly by household types. Agronomic evidence indicates that the number of days spent plowing and planting and the timing of those days relative to rains are the dominant determinants of cropping outcomes. Plot abandonment rates are significantly higher on plots planted later in the season and on those planted later after any given rain. The relationship between days plowing, area plowed, and sorghum harvested for different types of households is illustrated in Table 3-4.

Livestock husbandry. Research in Shoshong and Makwate revealed similar husbandry practices patterns to those reported nationally. When farmers were asked what were the most important uses of their animals, both cattle- and goat-owning households ranked milk consumption over sales. Draft power was considered the third-most important use of cattle,

Table 3-4

Days of Plowing, Area Plowed, Sorghum Harvested; 1983–84

	Sex of Head		*Cattle Assets*		*Draft Access*[a]		
	M	F	0–35	>35	C	D	All
Number of households	17	10	16	11	17	10	27
% Farms which plowed	94	80	81	100	100	73	78
Days of plowing	8.2	3.7	6.2	7.1	9.8	1.9	6.6
Area plowed per farm (ha)							
Total	4.5	2.5	2.4	5.7	5.2	1.7	3.8
Per person plowing	1.5	0.9	0.9	1.8	1.5	0.6	1.3
Per consumer equivalent[b]	0.6	0.4	0.3	0.8	0.7	0.3	0.5
Per day	0.6	0.7	0.4	0.8	0.5	0.9	0.6
Percent of Farms which harvested any sorghum	53	40	31	73	63	27	48
Sorghum harvested (kg)[c]							
Total	454	139	232	488	532	51	336
Per hectare	101	56	97	86	102	30	88
Per consumer equivalent	62	20	32	68	71	8	47
Per worker equivalent[d]	142	42	68	153	156	17	102

Source: 1983–84 Multi-Visit Resource Unit and Plot Monitoring Surveys; 27 households.

[a]C = Control, D = Dependent.

[b]Consumer equivalents figured for each household according to unit weights: age 0–4 = 0.20; age 5–9 = 0.50; age 10–15 = 0.75; adult women = 0.90; adult men = 1.00.

[c]Sorghum kilograms based on a standard conversion of 70 kg per bag of threshed grain. End-of-season farmer assessment data.

[d]Worker equivalents were figured according to number of persons active in plowing and planting (x 0.33), weeding (x 0.33), and harvesting (x 0.33).

still ahead of meat consumption. Donkeys were kept only for their traction services. Chickens were kept mainly for home consumption and were managed primarily by women. Men predominantly made milking decisions and decisions about small stock, but in one-third of the households these decisions were undertaken by women. Livestock practices are shown in Table 3-5.

Beer brewing. Sorghum beer is made by women. In most households beer is brewed on an infrequent basis throughout the year. Much sorghum beer is actually made with purchased maize meal due to a lack of sorghum. Returns to brewing labor are extremely low, nearly as low as cropping outcomes in a drought year and certainly lower during a good year.

Consumption. Sorghum, maize, and cowpeas are the primary constituents of most dishes. Sorghum is consumed in porridge and through drinking traditional beers. Maize kernels and meal are both used in different main dishes. Most dishes include leafy greens, milk, or meat. Due to drought, purchased maize meal replaced sorghum meal as the foundation of the diet, and many households were unable to eat sorghum at any time. Few households ate green maize, rice, cowpeas, or other beans, but around one-half of the households ate bread at least once a week. Consumption of most crop commodities increased as the season's harvest be-

Table 3-5
Livestock Practices

	Cattle[a]	Smallstock[b]	Donkeys
	Percent of Households		
Watering frequency			
Twice daily	7	0	26
Once a day	79	79	66
Parasite control			
Dosing	14	0	22
Dipping	29	3	14
Spraying	54	3	8
Vaccinating	93	0	28
None	11	79	34
Supplementation			
Hay	5	10	0
Bonemeal	20	7	6
Salt	27	24	20
None	71	55	78

Source: Livestock Practices Survey; 41 respondents for cattle, 50 for small stock, 29 for donkeys.
[a]Cattle kept at cattle post. Practices differed for cattle kept in or near village.
[b]Goats and sheep.

came available. This was not the case for maize or sorghum meal, since these were purchased by most households.

Market participation. Essentially all households bought food on a regular basis. Maize meal, tea, and sugar were the most frequently purchased items. Less than one-third of the households sold any crops during the prior five years, except for very small sales to neighbors. Forty percent of the households borrowed money through informal channels, but only 10 percent said they ever took a formal loan. Female-headed, poorer, and draft-dependent households were more likely to take informal loans, less

Table 3-6
Average Monthly Cash-flows

	Sex of Head		
	M	F	All
		Pula	
Sales			
Crops	0.46	1.14	0.70
Livestock	57.15	8.09	39.46
Beer	9.44	34.54	18.49
Other	1.78	0.83	1.44
Subtotal	68.83	44.60	60.09
Miscellaneous			
Gifts and loans	20.98	24.79	22.36
Wages	25.41	2.04	16.98
Other	4.83	1.69	3.70
Total in-flows	120.05	73.12	103.13
Purchases			
Inputs	2.16	8.56	4.47
Grain and meal	10.46	13.01	11.38
Other food	14.91	12.92	14.19
Livestock	3.23	0.00	2.06
Household goods	19.73	9.64	16.09
Other	1.53	0.83	1.28
Subtotal	52.02	44.96	49.47
Miscellaneous			
Gifts and loans	0.95	0.42	0.76
Wages[a]	25.72	30.14	27.36
Transport	4.04	2.74	3.57
Other	23.26	20.22	22.16
Total out-flows	105.99	98.48	103.32
Net cash-flow	14.06	-25.36	-0.19

Source: Multi-Visit Resource Use Monitoring Survey; 1983–84. 27 households.
[a]Includes fees paid for hiring traction.

likely to take formal loans. Most households purchased seed, but relatively few ever purchased other production inputs. Cash flows of male-headed and female-headed households are reported in Table 3-6.

Decision making. A series of individual interviews on roles in decision making showed that decision roles varied for different types of decisions. Children had relatively little say in either type of household. (See Table 3-7.)

Table 3-7

Roles in Decision Making (%)[a]

	Male-HH				Female-HH	
	MA[b]		FA[c]		FA[d]	
	Major say	Joint say w/others	Major say	Joint say w/others	Major say	Joint say w/others
Start plowing	69	17	10	14	27	10
Start planting vis-à-vis rains	69	17	37	19	37	11
Soil moisture adequate for plowing	43	48	14	43	58	26
Draft animals fit	73	23	5	15	26	13
Hire-in labor/traction	17	83	5	67	48	37
Hire-out labor traction	17	74	5	67	58	26
Help non-HH family	13	78	10	71	63	26
Try new tillage or planting method	13	87	10	81	69	32
Amount of seed to plant	0	74	62	33	79	21
Replanting	0	9	14	14	63	11
Weeding	13	0	62	29	79	5
Use non-HH weeding labor	22	65	10	81	69	26
Sell crops	13	78	5	86	69	32
Sell cattle	34	61	5	52	37	53
Sell goats	30	65	5	52	47	53
Use children in cropping activities	96	4	100	0	100	0
Allow children to migrate	91	0	71	0	89	5

Source: ATIP Survey Data; 1985 Decision Unit Profile Survey.
Key: MA = male adults, heads of household; FA = female adults; HH = household.
[a]Each respondent ranked his or her own role in each decision from 1 (= decide alone) to 5 (= not even involved in the decision). Categories 1 and 2 (= major say) have been combined in this table. Joint is category 3. Categories 4 (= discuss, not decide) and 5 have been omitted.
[b]Percent of all male heads of household *(N=23)*.
[c]Percent of all spouses of male heads of household *(N=21)*.
[d]Percent of all female heads of household *(N=19)*.

A second perspective on decision making was obtained by asking adult household members their perceived benefits or harm from changes in the farming system, relative to other household members. The benefits listed were increased cash from cattle sales, goat sales, beer sales, and remittances; more milk production, more crop production, and larger cattle herds. Generally, within male-headed households, male heads and female spouses indicated the benefit was the same. For male heads of households, benefits were relatively greater from cash from cattle sales, goat sales, and remittances; relatively less from beer sales. Nearly 20 percent of female spouses perceived beer sales as more beneficial to themselves than to other household members. For female heads of households, beer sales and remittances were slightly more beneficial than cattle or goat sales.

Local Institutions and Interhousehold Arrangements

Extension service. A regional survey confirmed that agricultural extension agents are not being very effective in their roles as agricultural change agents. Few demonstration plots are put in and most demonstrations fail. Their ineffectiveness is related to the number of nonextension service activities they do, emphasis on topics and practices stressed by the Department of Agricultural Field Services (DAFS) as opposed to locally established priorities, and conditions of service. All but four of fifty-two extension agents stationed in the Central Region were men.

Interhousehold draft arrangements. Draft or traction arrangements fall into several catagories. Decisions over the timing of plowing, the adequacy of soil moisture, and replowing depend on which arrangement is used. Households using their own traction have complete control over the timing and amount of plowing. Cooperative arrangements give rights to both partners; the normal control of traction owners is limited in order to have access to additional labor. Households borrowing traction animals usually do so for an entire cropping season and have almost free rights with respect to the use of borrowed traction and very few obligations. From a crop production standpoint, households able to borrow traction on a long-term basis have essentially the same control over the timing and amount of plowing as do users of owned traction and are considered traction controlling.

Households hiring traction are draft dependent and have the fewest rights with respect to timing decisions and the amount plowed; plowing often is not done when scheduled. Hiring is attractive to households that lack labor as well as traction. It is favored by some traction owners as well as nonowners because plowing is done quickly, particularly when tractors are hired. Tractors have become the most common type of traction during the drought seasons. Also during the drought, more house-

holds become dependent on other households for hiring traction, and many cooperative arrangements fall into disuse.

Village groups. Village- and household-level studies of groups in Shoshong and Makwate confirmed that groups are an important element of village life, but generally do not operate very effectively. Most groups suffered from poor attendance and a lack of commitment, and there was much overlap in the activities of groups such as the YWCA, Village Health Committees, and the Botswana Council of Women. Village Development Committees, the focal point of village development efforts, were not playing this role in either village. Farmers' Committees, the main support groups for the agricultural extension agents, were completely inactive. Various special purpose agricultural groups (such as fencing and tick-control groups) were among the most active village groups.

Group participation was not spread evenly among the population. The individuals who joined the groups tended to be older, heads of households, and wealthier than average. Large groups tended to become dominated by small subsets of active members who alienated the general membership. Groups which promised some benefits for general community welfare seemed to draw wider interest and membership, while those with personal benefits drew a more committed membership.

Experimentation: Results

Experimentation was discouraging because of three years of drought. A number of planned trials were not implemented because of farmers' preoccupation with their main fields, or discouragement leading them to abandon fields midseason to find alternative sources of income. One general finding from the results of several field trials and the early technical studies was considerable within field variability, particularly the distribution of soil moisture. The retention or nonretention of soil moisture strongly affects plant population density and yields over the length of a season. Though weeding was identified as a problem by women, the drought conditions precluded useful investigation. The planned experimentation and outcomes for the first three seasons are summarized in Appendix 3-C. Highlights are discussed below.

Leverage trials. Trials in sorghum fields were carried out for three years (1982–85). These trials were intended to evaluate (*a*) the effect of an early or sole plowing followed by (*b*) planting and different planting methods (usually combined with a second plowing). The experimenters believed that early plowing would possibly improve water infiltration of the soil and consequently improve crop response to fertilizer. During the first year, results were inconclusive except for two comparisons showing substantial benefits to double plowing in increased plant stands and yields.

The second year of sole-plowing-and-planting-method trials had two closely related objectives: (*a*) to evaluate the benefits of soil tillage done prior to a planting rain for crop emergence counts, uniformity, and vigor of stand in sorghum, and (*b*) to investigate planting methods for previously plowed fields. The second-year trial showed significant but not substantial benefits in plant stands and yields for two treatments—double plowing and row planting after early plowing. It was observed during these trials that, while women usually plant seeds when they are broadcast, men did the row planting because of the use of traction with a mechanized row planter. Farmers expressed concern over the opportunity cost of early plowing without planting.

The third year's plowing and planting trial focused on double plowing and row planting. Farmers were asked to implement the early plowing preparation under drying soil moisture situations (to reduce the opportunity cost of a lost day of planting). Most were not able to follow this guideline because the condition of their animals would not permit the harder work on drying soils, or they worried that the dry soil would ruin a plowshare. Plant stand number and plant height were significantly and substantially increased through early plowing. Combined results from three years' trials are reported in Table 3-8.

Economic analyses of double plowing (Table 3-9) and row planting after early plowing (Table 3-10) were prepared and each was compared to the traditional broadcasting and single plowing system. The comparison showed that both practices contribute to a net gain per hectare and a reasonable return for the extra labor invested in the sole-plowing operation. However, the economic analysis also showed that, when improved practices on one hectare are compared to traditional practice on two hectares, the new practices are less desirable. In other words, neither option should be pursued by farmers if doing so means they must reduce the area plowed and planted under the traditional system.

Nonleverage interventions. Results from trials on nonleverage interventions are mixed. The traditional cowpeas, Tswana and Blackeye, outperformed introduced varieties in most cases. Farmers stated a preference for cowpeas rather than special-purpose stover varieties because of the potential grain yield. The research station's ER-7 variety gave an excellent yield on a per plant basis, but establishment was erratic. Sri Lanka cowpeas and mung beans established and yielded well.

Attempts at intensifying production—through the introduction of *kraal* manure, through gap filling, or through the replanting of a whole plowed, but poorly established, field—either were not implemented or did not show promising results.

Informal analysis. During the first season the team observed that some technologies interested farmers more than others, even though no

Table 3-8
Sorghum Production Trials:
Grain Yield and Plant Stand Results[a]

Tillage Planting Treatments	Harvest Grain Yield	Plant Stand Count
	kg/ha[b]	plants/ha
Traditional checks[c]		
Day of sole plowing (BSP1)	141.6	18,034
Day of planting (BSP2)	119.1	18,034
Early plow plots		
Row planted (RPEP)	200.7	25,819
Broadcast-plow (BDP)[d]	202.1	32,215
Early plowing average	204.1	23,206

Key: BSP1 = broadcast, single plow 1 (traditional), same day as sole plowing;
BSP2 = broadcast, single plow 2 (traditional), same day as planting of earlier plowed fields;
BDP = broadcast, double plow (planting by broadcast on second plowing);
RPEP = row planting, early plowing (row planting after early plowing).

[a]Researcher-managed, farmer-implemented trials; 1982–83, 1983–84, 1984–85 combined.

[b]Results of the T-tests for paired comparisons of traditional and early plowed grain yield and plant stand results are as follows:

BSP2 vs. BDP:
Grain $t = 3.53$, $df = 18$
Stand $t = 2.62$, $df = 18$

BSP2 vs. Avg. Early Plowing:
Grain $t = 3.92$, $df = 20$
Stand $t = 3.18$, $df = 20$

BSP2 vs. RPEP:
Grain $t = 4.61$, $df = 17$
Stand $t = 2.80$, $df = 17$

BDP vs. RPEP:
Grain t = n.s.
Stand t = n.s.

[c]The traditional checks were broadcasting followed by a single plowing. BSP1 represents yields from traditional check broadcast and plowed the same day as the early or sole plowing. BSP2 represents yields from check plots undertaken the same day as the (later) planting of the experimental plots.

[d]The plowing indicated for the early plowed plots was a second plowing. The term "double plowing" (BDP) is used when the second plowing is used to incorporate broadcasted seed.

alternative was profitable during the drought. Also, it became clear that farmers within a resource category or research domain had differing reactions to various technologies. Inevitably observation and informal analysis based on interactions with farmers began to take on increased importance relative to formal data analysis of trial outcomes. During the second year, the team tried a structured approach to informal analysis. A farmers' workshop was held near the end of the season so that farmers from different villages could meet together to review and discuss trial outcomes. Twenty-eight farmers attended, of which nearly half were women.

Farmers were shown three trial sites with plowing and planting trials, including the researcher-introduced strips of phosphate, and cowpea variety trials sole-planted by traditional methods. Farmers showed modest interest in the tillage and planting methods trial. More interest was shown in

Table 3-9

Partial Budget of Sorghum Production Trials for Double Plowing (BDB) Compared with Single Plow/Planting (BSP)[a]

	BDP (1 ha) vs. BSP (1 ha)		BDP (1 ha) vs. BSP (2 ha)	
	Changes	Net Gain	Changes	Net Gain
	Pula			
Basic budget				
Reduced cost				
Seed saving	—		3.12[b]	
Weeding time saving	3.57[c]		12.46[d]	
BSP harvesting time[e]	8.90		18.46	
Added benefit				
BDP yield (198 kg)	77.22		77.22	
Added cost				
BDP second plow[f]	9.04		—	
BDP harvesting time	15.05		15.05	
Reduced benefit				
BSP1 yield (126 kg)	—		49.14	
BSP2 yield (117 kg)	45.63		45.63	
Net gain		19.97		1.44
Sensitivity analysis				
No weeding time saving		16.40		−11.02
Weeding time saving plus 50%		21.76		7.67
Labor at urban minimum wage (53 t)		18.95		7.71
Grain Market Board price (27 t/kg)		10.25		5.88
Hired traction (P 50/ha)		−20.99		1.44

Key: BSP = broadcast, single plow 1 (traditional)
BDP = broadcast, double plow (planting by broadcast on second plowing)

[a]Farmer-implemented trials; 1983–84 and 1984–85, combined.
[b]Seeding rate = 8 kg/ha. All grain valued at 39 t/kg.
[c]Weeding time was 9.4 hours less on double-plowed plots. All labor valued at 38 t/hr (the GOB village wage rate for drought relief activities).
[d]Weed times saving of 9.4 hours plus the 23.4 hours required for the second traditional plot.
[e]Based on harvesting and threshing rate of 5 kg/hr.
[f]The average plowing time was 11.9 hr/ha. Plowing labor was standardized to two people, and valued at 38 t/hr.

Table 3-10

Partial Budget of Sorghum Production Trials for Row Planting after Early Plowing (RPEP) Compared with Single Plow/Planting (BSP)[a]

	RPEP (1 ha) vs. BSP (1 ha)		RPEP (1 ha) vs. BSP (2 ha)	
	Changes	Net Gain	Changes	Net Gain
	Pula			
Basic budget				
Reduced cost				
Seed saving[b]	0.78		3.90	
Plow 2nd BSP plot	—		9.04[c]	
Weed 2nd BSP plot	—		8.89	
BSP harvesting time[d]	4.45		9.23	
Added benefit				
RPEP yield (201 kg)	78.39		78.39	
Added cost				
Hours row planting[e]	6.08		6.08	
RPEP harvesting time	7.64		7.64	
Reduced benefit				
SP1 yield (126 kg)	—		49.14	
SP2 yield (117 kg)	45.63		45.63	
Net gain		24.27		0.97
Sensitivity analysis				
Yields from 1983–84 trial only		22.86		–10.64
Yields from 1984–85 trial only		25.68		–26.48
Saving from cultivator weeding[f]		31.22		7.92
Labor at urban minimum wage (53 t)		20.61		6.28
Grain Market Board price (27 t/kg)		13.95		4.81
Hired traction (P 50 plow; P 25 plant)		10.35		28.01

Key: BSP1 = broadcast, single plow 1 (traditional), same day as sole plowing;
BSP2 = broadcast, single plow 2 (traditional), same day as planting of earlier plowed fields;
BDP = broadcast, double plow (planting by broadcast on second plowing);
RPEP = row planting, early plowing (row planting after early plowing).

[a]Farmer implemented trials; 1983–84 and 1984–85, combined.

[b]Row plant seeding rate = 6 kg/ha. Broadcast seeding rate = 8 kg/ha. All grain valued at 39 t/kg.

[c]Plowing rate of 11.9 hr/ha. Standardized to two people plowing. All labor valued at P 0.38/hr.

[d]Based on harvesting and threshing rate of 10 kg/hr.

[e]Row plant rate of 8 hr/ha with two people planting.

[f]Saving from cultivator weeding of 18.3 hrs/ha.

the effects of phosphate application. For follow-up discussions, farmers were divided into groups based on whether they were draft controlling or draft dependent. Both sets of farmers said they saw benefits in the modified plowing and planting systems, but most were concerned about resource constraints. Draft-controlling farmers were concerned about the extra labor required and the wear on their equipment. Draft-dependent farmers stated that they had no access to traction when they needed it.

Farmers expressed interest in the sole planting of varieties. Anticipated benefits were the absence of competition between plants of different types and the possibility of field rotations to control pests. Problems seen were the difficulty of carrying out simultaneous activities (such as picking jugo beans and scaring birds from sorghum) and the greater labor requirements. Nonowners felt that the main discussion of multiple tillage, sole planting and draft management were mostly relevant to traction owners. Other problems raised by the farmers during the discussion were crop destruction by livestock, bird damage and the time spent on bird scaring, and labor shortages, particularly during weeding.

END OF REPORT

DEAN'S REFLECTIONS

As Dean scanned his report for the review team, he thought again about how much they had learned during the first three years. At the same time, he realized that several issues would have to be resolved before they could begin planning for the coming season. He hoped the review team would bring new insights to some of the issues that had repeatedly arisen.

STUDY QUESTIONS

1. How do the resources and activities of women and men differ in Botswana?
2. Evaluate the potential benefits and the sociological fit of the plowing and planting trials.
3. How do the categories of female-headed households and women farmers fit with the definition and concept of research domains as used by the CRT?
4. What should be the priority research activities in the next season? What are the objectives and who would benefit?

NOTES

1 The case is based on work of the Appropriate Technology Improvement Project (ATIP), Mahalapye District, Bostwana. Because the case required work beyond that supported by the Population Council/FSSP Case Studies Project, the case could not have been prepared without the support of David Norman, ATIP Chief of Party.

ATIP Mahalapye has been a joint effort, in design and implementation. Most of the experimentation and technical monitoring activities cited in the case were designed by Dr. Jay Siebert, agronomist for the Mahalapye team since its start. The burden for much of the field work fell on the shoulders of the Government of Botswana professional counterparts and village staff. Without the help of the following counterparts, the program could not have been implemented: Catherine Jonas, John Lesothlo, Jonah Luzani, Eliza Modiakgotla, Chada Tibone, and Meshack Tjirongo.

For the most part, the case accurately represents the activities, approaches, and findings of the Mahalapye team. Some simplifications have been made and some issues have been introduced in order to improve the case as training material. The case should not be viewed as a complete accounting or evaluation of the Mahalapye research program.

2. "Traction" refers to the use of animal or mechanical power for agricultural production activities. In Botswana, traction is principally used for land preparation.

3. A "leverage point" is an area of critical constraint which, once solved, would open up possibilities for further improvements. Nonleverage interventions do not necessarily address the most critical constraint but can improve farm system productivity.

Appendix 3-A: Agricultural Programs in Botswana

The major units responsible for research and extension activities are the Departments of Agricultural Research (DAR) and Agricultural Field Services (DAFS), respectively. The primary locations for arable crops research are the main experiment station at Sebele (ten kilometers from Gaborone, the capital) and four substations. Livestock research is conducted by the Animal Production Research Unit (APRU) on Ministry of Agriculture (MOA) ranches spread throughout the country. DAFS is responsible for all direct farmer contacts by the Ministry of Agriculture, except for those by the on-farm research teams and the extension activities of the Departments of Animal Health and Cooperatives. Extension work is funneled through village-level agricultural demonstrators.

The cornerstone of the strategy for agricultural development is the Arable Land Development Program (ALDEP), through which resource-poor farmers can obtain fencing, implements, and traction at greatly subsidized prices. Fencing is the most sought-after package. On-farm research emerged as a government priority in the mid-1970s, and several projects to test cropping systems, including new equipment, were carried out in the late seventies. Building on these prior experiences with on-farm research, and to complement the ALDEP program, the Ministry of Agriculture adopted the farming systems approach in the early 1980s.

To carry out farming systems research in the Central Region, the Central Region team (CRT) was established in 1982, cosponsored and jointly funded by the Government of Botswana and the United States Agency for International Development (USAID). Two field teams were established at Francistown and Mahalapye. Each team consisted of two agronomists and two agricultural economists and field staff from the Ministry of Agriculture. (See Table 3-A.1.)

The field teams were nominally linked with DAFS, DAR, and the Division of Planning and Statistics (DPS) through assignment of officers to the CRT. The Mahalapye team was located at the district headquarters for DAFS.

Table 3-A.1

Composition of Central Region Farming Systems Team

	Male	Female	Total
Agronomist			
Years 1, 2, 3	2	0	2
Agricultural Economist			
Year 1	2	0	2
Years 2 & 3	1	1	2
Rural Sociologist			
Year 3	0	1	1
DAFS field staff			
Years 1 & 2	2	0	2
Year 3	2	1	3
Enumerators			
Year 1	3	0	3
Year 2	2	1	3
Year 3	2	0	2
Seasonal village staff			
Years 1, 2, & 3	0	2	2

Appendix 3-B: Selected Research Activities, First Three Years

Activity/Purpose	Description	Sample/Person Interviewed	Interviewers	Time Frame
Resource monitoring to characterize situations of different household types and roles of household members	Monitored whole farm resource flows through twice-weekly interviews	27 households (17 male-headed, 10 female-headed); any available member, usually was senior female (head or spouse of male head) or eldest resident daughter	Three field assistants: three males first year, two males and one female second year	Two years
Resource monitoring (year three) to get better data on returns to key farm enterprises	Monitored only income-related input and outflow	13 households	Same as second year	One year
Technical plot monitoring to identify main technical determinants of cropping outcomes	Measured selected husbandry and environmental variables that contribute to cropping outcomes	25 farmers doing on-farm trials (18 male-headed, 7 female-headed)	Two senior male field assistants and temporary staff	Three years
Inventory surveys to detail farm inventories	Included household census, livestock inventory; inventory of farm fixed capital, including buildings	All 52 cooperating households	One senior female staff	Two years

Farm management surveys to broaden understanding of circumstances affecting farm and household desicion-making	a) Crop management b) Draft arrangements c) Livestock practices d) Farm/household decision-making	All 52 cooperators plus single random selection for certain surveys. Senior female most frequent respondent	Two to four senior staff	Each one time only; done periodically during four years
Institutional sudies to assess impact of rural institutions on farmers' opportunities	a) Extension agent activities b) Village leaders and group activities c) Trading establishments	a) All agricultural demonstrators b) Members of local groups c) Local traders	Two to four senior staff	Each one time only; done periodically during four years
Technical studies to increase understanding of specific technical topics	a) Soil variability b) Weed burdens and compositions c) Soil determinants of the depth of sorghum rooting d) Microtopographical variation e) Vegetation cover	Selected locations meeting technical requirements	Two senior staff and field assistant	Done periodically over the four years

Appendix 3-C: Experimentation and Outcomes, First Three Years

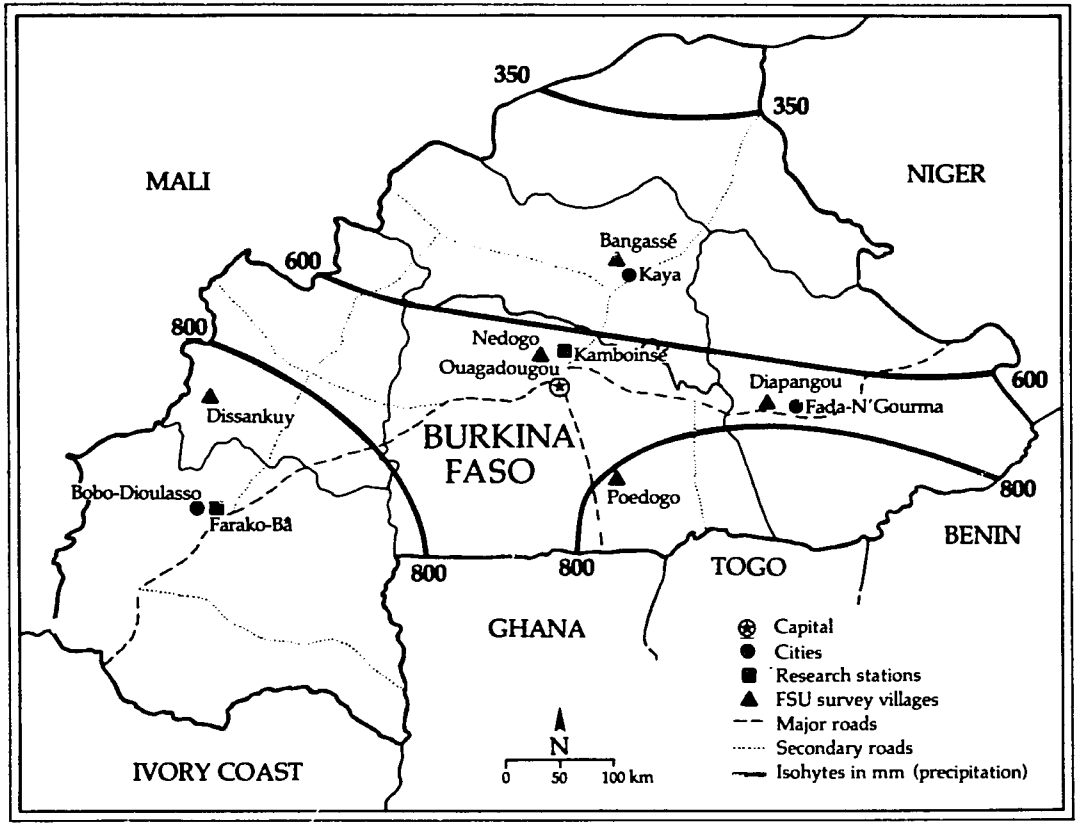
Trials	Outcomes
First year	
1. Evaluation of planting methods (22 farmers: 13 males, 9 females)	Drought, no significant yield
2. Double plowing (2 fields: 2 males, 0 females)	Benefits to plant stand and grain yields
Second year	
1. Effects of early tillage and different planting depths (2 fields: 2 males, 1 female)	Early benefit for plant stand and vigor; but drought precluded measurable yield
2. Sole plowing and planting methods (16 farmers: 12 males, 4 females; 5 nontraction controllers not included)	Benefits to double plowing and early plowing plus row planting (See text)
3. Draft team management, supplemental feedings (5 farmers: 5 males, 0 females)	Little farmer interest
4. Cowpea cropping comparisons: introduction of new varieties and different sorghum/cowpea intercrop mixtures (31 farmers: 22 males, 9 females)	Only a few sole cropping of varieties carried out; traditional Blackeye and Tswana better than ER-7
5. Evaluation of phosphate benefits (RMRI strips across sole planting trial above); (10 farmers: 8 males, 2 females)	No measurable benefit

Third year—Design stage	
1. Commercial steps in technology; evaluation of inputs for farmers able to go into commercial production: subsoiling, early plowing, phosphate fertilizer, different planting methods (RMRI, 5 sites: 4 males, 1 female)	Significant but not substantial benefits from subsoiling and phosphate fertilizer. Only substantial treatment effect from row planting.
2. Nonleverage interventions a) Draft management b) Intensive production plots for low rainfall conditions c) Undersowing of legumes (13 farmers: 5 males, 8 females)	See text Traditional varieties did better and farmers expressed preference for cowpeas for possible grain yield
Third year—Testing stage	
1. Improved tillage/planting scheme: double plowing, and early plowing with row planting with 2 soil moisture conditions defined by farmers (16 farmers: 14 males, 2 females)	See text
2. Replant strategy; indigenous practice	Not implemented because of late rains
3. Cowpea variety planting trial (8 farmers: 4 males, 4 females)	Most replications never implemented due to drought. In five cowpea comparisons which produced yields, local varieties—Tswana and Blackeye—outperformed station variety ER-7 in emergence and yield.

Key: RMRI = research-managed, researcher-implemented trial; RMFI = researcher-managed, farmer-implemented trial; FMFI = farmer-managed, farmer-implemented trial.

Figure 4-1

Map of Burkina Faso Showing Rainfall Distribution and Farming Systems Unit Research Sites



Chapter 4

Burkina Faso

A Case Study of the Purdue University Farming Systems Project

JOSEPH G. NAGY, HERBERT W. OHM, AND SIBIRI SAWADOGO

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Part 2 Experimentation and Monitoring (in *Working Together*, Volume 2)

Part 3 Evaluation, Modifications, Recommendations, and Dissemination (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

Burkina Faso: Part 1
Country and Project Background

In 1982, members of the Purdue/SAFGRAD Farming Systems Unit (FSU) team sat down to discuss what they had learned about the farming systems of the communities in which they worked and to plan the next year's program of research trials and socioeconomic surveys. Prior to the meeting, the team leader had asked each of the team members to review what they knew about Burkina Faso (Appendix 4-A). They then went over what they had learned in the previous several years' surveys and discussed the technologies available for on-farm experimentation.

PROJECT BACKGROUND

Food Security and Government Policy

Since achieving independence from France in 1960, Burkina Faso has had to cope with the problem of food security—the ability to assure consumption of a nutritionally adequate diet for all members of the country. Although increases in food availability have kept pace with population growth, allowing per capita consumption to remain constant, aggregate caloric intake was 85 percent and lipid consumption 50 percent of nutritionally recommended levels. On average, protein consumption was adequate (Haggblade 1984, vii). Assuming a 2.6 percent rate of growth in population, total food production would have to increase by 30 percent by 1990 to maintain the current consumption levels without greater reliance on imports (Singh et al. 1984, 5).

The government strategy to deal with food security and other problems was outlined in 1977 in its third Five-Year Plan (1977–1981), and it set forth three national objectives: (1) improved living conditions, (2) self-sufficiency in food, and (3) reduction in underemployment. The agricultural sector was given special attention and was charged with the objectives of replacing food imports with increased cereal production and diversifying into export (cash) crops. The objectives were to be achieved by providing attractive product prices, improving farming practices, allowing migration to new lands, diversifying into new cereal and export crops, constructing rural roads, and integrating rural development projects.

	BURKINA FASO
Area	274,000 km^2; 50% arable.
Population	7.2 million; growth rate 2.6%; 90% rural.
Income	GNP/capita: U.S. $180 (1981), growth rate 1.1%. Sources: agriculture (41% of GDP), emigration for wage labor. Exports: cotton (41%), livestock and livestock products (25%).
Topography	85% plains; 3 major river basins: Comoe, southwest; Niger, east; and Volta, most of country.
Elevation	Plain is 200–350 m above sea level.
Temperature	June–September: 27–32° C; October and May: 4° C; November–March: warm and dry; March–May: hot and dry; June–October: hot and wet.
Rainfall	500 mm in NE to 1400 mm in SW. Since 1960s has averaged 100 mm below long-term average. Rainy season is from April to October.
Currency	FCFA (of the West African Monetary Union), floats with the French franc. 50 FCFA = 1 FF. FCFA 475 = U.S. $1 (Second Quarter, 1985).

	CENTRAL PLATEAU **VILLAGES: BANGASSÉ, NEDOGO, AND DIAPANGOU**
Area	ca. 233,000 km^2.
Population	Density 48/km^2 on Central Plateau.
Income	Sources: farming, wage labor, beer making.
Rainfall	Region 600–900 mm (based on 18–59 years of data prior to 1977) 1984 data: Bangassé—514 mm; Nedogo—452 mm; Diapangou—458 mm.
Elevation	200–250 m.
Soils	Shallow alfisols poorly constructed; predominantly sandy clay with some sandy loam; acidic; deficient in phosphorus, nitrogen, and organic material.
Vegetation	Bushes and scattered trees; undergoing slow deforestation.

The plan emphasized rainfed agriculture with limited and gradual expansion of irrigation. A floor price for buying cereals along with buying and selling quotas was established every year. The 1982 prices for sorghum and millet were 65 FCFA per kilogram and 50 FCFA per kilogram for maize. Fertilizers and agricultural chemicals were subsidized (about 40 percent). The World Bank claimed that government policy favored the agricultural sector. "The barter terms of trade have consistently made agricultural production more attractive relative to nonagricultural activities, as indicated by the fact that increases in agricultural output prices, both official and market, for food staples (millet, sorghum and maize) have increased faster than the index of general inflation or the prices of purchased agricultural inputs" (World Bank 1981, 2).

The year 1977 also marked the initation of the Semi-Arid Food Grain Research and Development Project (SAFGRAD), a regional coordinating program of the Organization in African Unity (OAU). The major objective of SAFGRAD was to "improve sorghum, maize, millet, cowpea and groundnuts and develop cultural practices to maximize yields under semi-arid farming systems of the sub-saharan region of Africa" (OAU/STRC/SAFGRAD 1984, 2). The agricultural institutions serving Burkina Faso are described in Appendix 4-B.

The Farming Systems Unit (FSU)

Farming systems research within SAFGRAD was initiated through a contract with the United States Agency for International Development (USAID) and implemented by Purdue University. Within the SAFGRAD framework, the objectives of the FSU were (1) to identify the principal constraints to increased food production, (2) to identify technologies appropriate for farmers which can minimize the production constraints, (3) to develop and implement a multidisciplinary research method which can guide production technology and production research to directly address these production constraints, and (4) to identify the elements of that method which can be implemented in national farming systems research program (Ohm et al. 1985a, 2).

The domain in which FSU was mandated to complete its objectives and do its research was a reflection of the objectives of SAFGRAD, the donor USAID, and Burkina Faso: (1) to work in a semiarid region, (2) to work principally on staple cereal crops, cowpeas, and groundnuts, (3) to work with small farmers (a USAID objective), and (4) to work with an emphasis on the Mossi plateau region of Burkina Faso. Within the Mossi plateau region, FSU selected three different agroclimatic zones to work in with differences in rainfall, soil quality, and access to land.

FSU was first staffed in 1979 and was stationed in Ouagadougou. The initial professional staff included an agronomist, an economist, and an anthropologist. Two subsequent teams included an agronomist, an economist, a junior economist, and one or two Peace Corps volunteers (PCVs). In 1979 farming systems methodology was in its infancy. Although previous on-station research had been conducted, little technology existed that was ready for on-farm testing. The component researchers with SAFGRAD itself had only started their research and had little to offer the on-farm testing phase of the project. Also, little was written about the socioeconomic environment and the farming systems of the area. The first FSU team's efforts were largely exploratory; making contacts, collecting initial socioeconomic data, and experimenting with a few on-farm trials. This information base allowed the second team to conduct

a diagnostic survey program which would provide guidance to their eventual program in the field.

Methodology: Diagnostic Phase

To achieve FSU's objectives, both secondary and primary diagnostic information was collected. In 1982, project resources permitted the FSU team to conduct work in three village sites. The criteria for village selection included that the villages represent distinct agroclimatic zones with different agricultural potential on the Mossi plateau, and that they represent, as far as possible, a complete range of tillage practices. Using these criteria, FSU contacted the local development agency, the Organisme Regional de Développement (ORD), in several areas. Together they selected potential villages and met with the village councils. At a general meeting for each village, FSU's objectives for the role to be played by the farmers were explained. The farmers, as a group, were given a week to decide if they wanted to participate.

Three villages were selected: Bangassé—110 kilometers northeast of Ouagadougou and 15 kilometers from the major center of Kaya; Nedogo—30 kilometers northwest of Ouagadougou; and Diapangou—210 kilometers east of Ouagadougou and 15 kilometers from the major center of the Fada-N'Gourma (Figure 4-1). Bangassé and Nedogo are more densely populated than Diapangou. Bangassé has very few animal traction farmers whereas about one-half of the farmers in Nedogo use donkey traction. Diapangou has the greatest agricultural potential followed by Nedogo and then Bangassé. The ethnic origin of Bangassé and Nedogo is Mossi, while Diapangou is predominantly Gourmantche.

Two to three permanent field staff were hired to live in each village to become familiar with the farmers, administer questionnaires, and supervise field work. A census of each village was taken. Random samples of between thirty to thirty-five households in each village were drawn. The sample sizes were determined to be large enough to derive statistically useful research findings, yet their size was also manageable. The samples in Nedogo were stratified by traditional (manual) tillage and animal traction. Diapangou's sample was stratified by donkey and ox traction. The definition of a household unit was taken to be a group of people who came under the direction of one person (usually an elderly man) who in turn controlled the resources of the group and made the final production and consumption decisions. In most cases the head of the household was interviewed when surveys were conducted. Within the randomly selected sample of households in each village, one female-headed household was found.

A survey of each sample household was undertaken to obtain demo-

graphic characteristics and resource endowments. A diagnostic survey was also conducted with the following themes: farmers' goals and objectives, factors affecting cropping decisions, and production constraints. The questionnaires were tested on two to three farmers before being administered to the entire sample. The diagnostic survey provided information on the farming systems in each village. Information was also gathered from the first team's experiences, the knowledge from established researchers in the Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT), the International Institute for Tropical Agriculture (IITA), and from the farming systems unit that serviced its scientists within the International Crops Research Institute for Semi-Arid Tropics (ICRISAT), as well as from studies by McMillan (1979, 1980) and Saunders (1980).

FARMING SYSTEMS DIAGNOSIS

Physical Conditions

The soil characteristics of the northern Sudanian area and the southern Sudanian area presented in Table 4-1 correspond to the soils of the northern and southern Mossi plateau. The soils contain only weak aggregates, and after a rain the soil surface dries and forms a crust which restricts water infiltration and aeration and increases rainfall runoff (Kowal and

Table 4-1

Soil Types of Burkina Faso

Location and Soil Type	Soil Texture			Organic Matter	pH Water	Cation Exchange Capacity	Exchangeable Cations		
	Sand	Silt	Clay				Ca	Mg	K
	%					me/100 g Soil			
North Sudanian									
Yako area (Alfisols—bush field)	70.2	21.7	8.2	0.95	6.6	6.3	1.80	0.40	0.25
South Sudanian									
Boromo area (Alfisols—bush field)	65.6	28.4	5.9	0.96	6.5	4.7	0.90	0.25	0.13
(Alfisols—household field)	59.3	30.7	10.1	1.07	7.4	5.7	2.00	0.45	0.45

Source: H. Vierich and W. Stoop (1984).

Kassam 1978). In the dry season the soils harden, making preplant cultivation difficult and almost impossible by traditional methods until there is a major rain. In the wet season, rainfall levels and rainfall distribution is highly variable and unpredictable. Combined with the properties of the soil, they lead to water retention and soil erosion problems.

There is a slow but continual deforestation of the Mossi plateau. A growing population pressure has increased the use of wood for cooking and for other household purposes. There are some reforestation programs, but their number is not at a level to keep pace with the deforestation.

Household Characteristics

A traditional household whose members dwell together in a compound generally consists of a male head of the household, his wife or wives, and their young children. The size of the household varies and might include the adult sons of the head and their wives and children. Men, women, and children are involved in agricultural activities. The demographic characteristics and resource endowments of the FSU villages are presented in Table 4-2. A survey by the first FSU team of several Mossi villages indicated that only about 5 percent of household heads have any schooling and that the average age of household heads is 56.4 years (Singh et al. 1984, 16).

Table 4-2

Demographics of FSU villages

Characteristic/Endowment	Bangassé	Diapangou	Nedogo
Members per household	9.07 (3.76)[a]	9.50 (5.34)	10.67 (4.44)
Active workers per household[b]	5.77 (2.62)	7.27 (3.54)	5.36 (2.13)
Active male workers	2.13	2.10	2.03
Active female workers	2.24	2.63	2.80
Active child workers	1.40	2.53	0.53
Hectares per household	2.15 (.91)	6.93 (3.41)	7.14 (3.93)
Hectares per person	0.263 (.129)	0.683 (.252)	0.682 (.335)
Hectares per active worker	0.34	1.06	1.34
Total households	30	30	30
With donkey traction	4	10	13
With ox traction	—	20	4

Source: Lang et al. (1984), 51.

[a]Standard deviations in parentheses.

[b]Active workers refers to all workers who are available for household, agricultural production, and herding work and does not include members of the household working in the cities or other countries.

Cropping Patterns

The principal food crops are sorghum, millet, and maize. White sorghum is grown in Bangassé and Diapangou, and both red and white sorghum are grown in Nedogo. Small quantities of rice are also grown. Most of the sorghum and millet fields are intercropped to some extent with cowpeas, and in Diapangou a mixture of millet and sorghum is often used. Other crops include okra, peppers, and sesame, which are often planted as field borders near the compound. Cash crops grown include peanuts, bambara nuts, and cowpeas, some of which go for self-provisioning. Cowpeas are not generally grown in Bangassé, while some soybeans are grown in Diapangou. Cowpeas are mainly grown for grain, but the leaves are often used for fodder as well as for human consumption. Cowpeas are intercropped at random along cereal rows and planted at a density of three thousand to five thousand plants per hectare. Cowpeas are rarely sole-cropped, and when planted at higher densities they suffer from increased diseases (bacterial blight, brown pod blotch, scab, and cercospora leaf spot) and insect problems (aphids, Maruca, thrips, Bruchid, and storage weevil). Mangoes are also grown as a source of food and for market in certain areas of the Mossi plateau. The proportion of land sown by crops is presented in Table 4-3. Average yields are presented in Table 4-4.

Table 4-3

Allocation of Cultivated Land by Primary Crop

	Bangassé		Diapangou		Nedogo	
	ha	%	ha	%	ha	%
Red sorghum	—	—	—	—	39.67	10.0
White sorghum	51.46	26.2	26.51	6.6	70.65	17.8
Millet	108.76	55.3	62.50	15.5	253.17	63.7
Associations[a]	15.77	8.0	264.03	65.3	0.31	0.0
Maize	3.36	1.7	12.77	3.2	9.37	2.4
Rice	2.91	1.5	4.73	1.2	1.31	0.3
Total cereal	182.26	92.7	370.54	91.8	374.48	94.2
Peanuts	10.94	5.6	18.58	4.6	19.49	4.9
Bambara nuts	2.34	1.2	2.33	0.6	2.66	0.7
Cotton	0.22	0.0	0.04	0.0	0.10	0.0
Soybeans	—	—	6.49	1.6	0.00	0.0
Cowpeas	—	—	5.27	1.3	0.10	0.0
Total cash	13.50	6.8	32.71	8.1	22.35	5.6
Total other	0.88	0.5	0.96	0.2	0.71	0.1
Total hectares	196.64	100.0	404.21	100.1	397.54	99.9

Source: FSU/SAFGRAD (1984), 16.
[a]74–90% millet; remainder sorghum.

Table 4-4

Yield and Farm Price of Major Crops

	1977–81 Average Yield[a] (kg/ha)	1981 Producer Price[b] (CFA/kg)
Sorghum	622	50
Millet	402	50
Maize	863	50
Rice	773	68
Peanuts	455	88
Bambara nuts[c]	577	88
Cotton	809	62
Cowpeas[d]		
Sole cropped	254	55
Association	45–55	55
Sesame	171	84
Peanut	NA	43

Sources:
[a]FAO Production Yearbook, Rome, except where indicated.
[b]Haggblade (1984) except where indicated.
[c]Jaeger (1985) for yield. Price not available but historically similar to peanuts.
[d]Saunders (1980) for sole-cropped yield, and Roth et al. (1984) for association yield. Price set at historical levels just above sorghum price.

Crop Husbandry

A labor calendar of activities performed on various crops typical for the three villages is presented in Figure 4-2. Table 4-5 outlines the gender division of labor activity between men and women. Most of the agricultural activities are done manually; some households use animal traction. Field preparation for planting mainly takes the form of clearing the land. Little preplant cultivation is done because of the soil characteristics, even when households have animal traction. Planting begins with the first significant rains, thus the actual date varies and accordingly adjusts the remaining activities throughout the cropping season. The first major rains come between the beginning of May and the end of June. All planting is done manually, by making a hole in the ground with a short handled hoe *(daba)* with one hand, placing several seeds from a calabash in the hole with the other hand, and then using the *daba* to cover the seeds with soil. Where animal traction is used for weeding, lines are traced out on the field to mark row spacings so that planting is done in a straight line. Row spacings for the staple crops are usually seventy-five centimeters with plant population densities of around fifty thousand to sixty thousand plants per hectare. Depending on seed germination and plant emergence, it might be necessary to reseed or replant part or all of the fields in certain years. A thinning operation is usu-

Figure 4-2

Gender Cropping Calendar for the Mossi Plateau

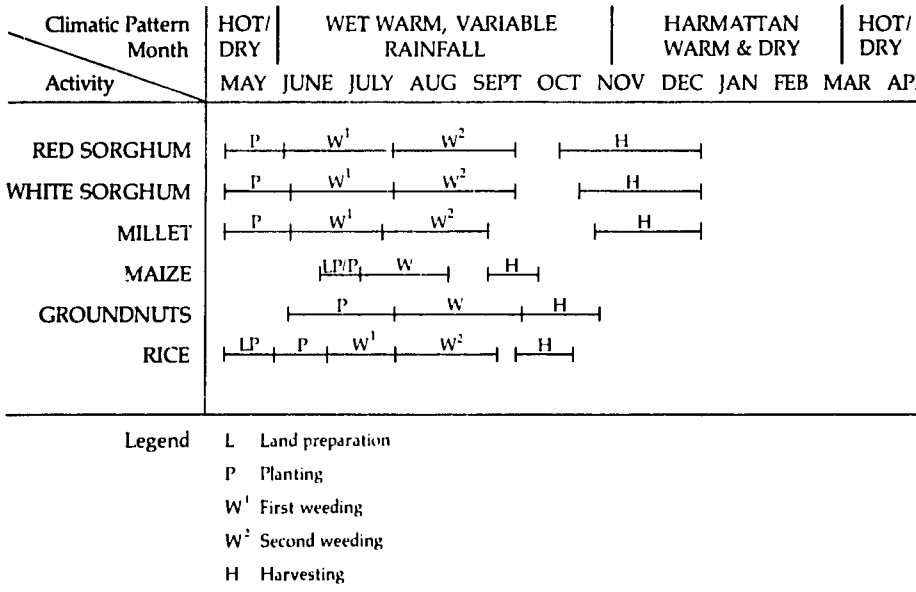

Table 4-5

Gender Division of Labor Activities[a]

Predominantly Male	Predominantly Female	Both Male and Female
Prepare fields	Fetch water	Planting
Construct fences	Fetch wood	Replanting
Guard fields	Meal preparation	Weeding
Small stock work	Beer making	Apply fertilizer
Large stock work	Domestic chores	Harvest
Weave straw	Commerce (beer and food items)	Poultry work
Construction	Child care	
Commerce (large items)	Spin cotton	

Source: Adapted from Delgado (1979).

[a]Because the gender division of labor is flexible, the criterion for classification of an activity as being predominantly male or female is that at least three-quarters of all the hours devoted to an activity come from the gender in question.

ally conducted three to four weeks after seeding, and the thinned plants are used to replant the spots in the field where plants did not germinate.

Weeding is done either manually or by a combination of manual labor and animal traction. When done manually, the *daba* is used for weeding between the rows and among the plants. At the second weeding stage, soil is placed at the base of the plants to keep them from lodging. When weeding is done by animal traction, a *houe manga* (cultivator) is pulled between the rows and is followed by a manual weeding among the plants in the row. At second weeding, the cultivator is fitted with a large shovel or middle sweep that not only does the weeding but also places the soil at the base of the plant, again to prevent lodging.

Maize is harvested at the semi-hard stage, and it is usually consumed directly from the field beginning in the latter part of August. The main harvest (sorghum and millet) usually takes place in mid-October, which is also the beginning of the dry season. The stalks are cut by the men, left in the field in a large sheaf, and the heads are allowed to dry in the sun. The panicle is then cut from the stock and carried to the household compound, mainly by women, and stored in granaries. Sorghum grain is seldom separated from the panicle; however, millet is usually separated by the women later on in the year, around January or February. Little crop residue is left in the field because the stalks are used in the household and for livestock feed, and fields are often burnt. Other dry-season activities include construction of buildings and fences, weaving of mats, pottery work, and other craft work. It is also the main season for visiting, parties, marriages, and ceremonial duties.

Livestock

Livestock are an integral part of the farming system, and most households own cattle. Nearly half of the Mossi and over one-third of the Gourmantche cattle owners send their cattle in transhumance—the seasonal movement of livestock between pasture zones (Vengroff 1980, 62). Sixty to seventy percent of the cattle owners send their cattle with sons or relatives and the rest with contract herders such as the Fulani. Transhumance is more frequent in the northern part of the Mossi plateau. Migration times and distances vary. Departing in September and returning in November or departing in November and returning in May is common. Distances range from 30–120 kilometers. Cattle left behind are herded by young boys and older men. It is rare for Mossi women to own cattle (Henderson, in Vengroff 1980, 115). The majority of animal traction work on the Mossi plateau is done by donkeys. Some oxen and a few horses are also used for traction work. As with cattle, little supplemental feeding is done, thus the traction animals are very weak in the first part of the agricultural (rainy) season.

Each household has some small ruminants (sheep and goats) and poultry, which are owned mostly by women. They are either bought or received as gifts from their husbands. Small ruminants are considered to be a good investment, and the women can sell their livestock with the permission of their husbands (Henderson, in Vengroff 1980, 117). Few animals are ever penned, though in the cropping season many are tethered. They are cared for mainly by children. There is a high death loss among the animals, and little vaccination is done against disease.

Beer Making

Non-Muslim women are involved in the making of a sorghum beer called *dolo*. *Dolo* is made from either red or white sorghum. Women make it for home consumption (usually feasts) or for selling in the market. If the beer is made for the family, the sorghum comes from the communal fields; but if the beer is made for market, the sorghum is usually bought. Women have the right to spend the income from *dolo* sales, usually purchasing clothing and condiments and, in times of food shortages, millet. In some villages, *dolo* making is regulated to permit everyone a turn at making and selling it.

Food Preparation

Millet, sorghum, and maize are prepared by first pounding the kernels into a flour and then adding the flour to boiling water until the mixture becomes a thick paste (called *tôt*) which is the basic food in Burkina Faso. Continual mixing is required to keep the *tôt* from becoming lumpy—which is undesirable. A sauce to be eaten with the *tôt* is prepared separately. To prepare the sauce, the leaves and other vegetative parts of plants and trees are boiled in water. Some common sources are the baobab tree, cowpeas, okra, *oseille* (sorrel), and kapokier (the silk-cotton tree). Spices are added, such as the fermented grains of *oseille* and *nere* (a tree with pods), as well as salt. Concentrated potassium filtered from the ashes of burnt sorghum stalks is often used for flavoring. Dry fish also is frequently added to the sauce. Sauces differ depending on the seasonal availability of their contents and the region in which they are produced. Fresh leaves are used for sauces made in the wet season, whereas dried leaves are used during the dry season.

Usually two substantial meals are eaten each day—one before noon and one in the evening. The evening meal is more carefully prepared as are both the meals during the dry season. In the wet (agricultural) season, the demand for women's labor in the field precludes extra time for food preparation. At times, sorghum or millet is cooked as a whole grain with cowpeas added to cut down on preparation time—especially for the morning meal. Occasionally millet is eaten uncooked by busy field workers.

Meat is rare in the diet. It may be used to flavor the sauce for the *tôt*, or it may be boiled and eaten with the sauce. Another common way of preparing meat is to cook it on brochettes. Rice is also rarely eaten and, along with meat, is food associated more with feasts. Fruits such as mangoes are part of the diet, as are limited amounts of cow and goat milk, which are consumed mainly by the herders (Kinseyinga Sawadogo, conversation with Joseph G. Nagy, May 1986).

Land Tenure

Although land is never privately owned, there are different degrees of tenure security depending on where the rights to control the land come from.[1] A household's claim to land is through membership in one of the several clans of a village. The size and quality of the land claim depends on the order of arrival of the clans in the village (the largest and best claims go to first-comers) and their relationship to the chieftaincy. Within each household, land is passed from father (household head) to eldest son, and the household head is given an "individual right" to the control and distribution of the land to household members with little interference from clan elders. The household head has the right to subdivide the inherited land. There is a distinction between collective or communal fields of the household, which provide the major subsistence crops (sorghum, millet, and maize), and private or personal fields, which individuals cultivate for their own use. The location and size of the private fields of various members of the household is decided by the head. Women do not inherit land but obtain the right to use land through their husbands. The best quality land is usually reserved for the communal fields and tends to have slightly higher yields because of the ability of the household head to command labor at the optimum planting and weeding times. The distribution of land in Bangassé is shown in Table 4-6. Compound land, which is closest to the dwelling place, generally belongs to the household head or is communal.

Another form of land tenure is a "customary right" held by the clan elders and the village chief. A major portion of the land cultivated in a village is borrowed land from households that have sufficient land for their own needs or from those having land through customary rights. This form of tenure allows for adjustments in family size and composition over time. Lenders of land usually receive token payments such as kola nuts, salt, or a tine of grain (eighteen to twenty kilograms) each year. Borrowers have temporary cultivation rights, but usually are not given the rights to gather straw, firewood, or fruits and leaves of trees from the land. Lenders guard the rights to their land by lending land for short periods, usually for less than five years, and not lending their best land or land used for subsistence crops. The amount of land in each tenure category differs from vil-

Table 4-6

Land Distribution and Cultivation in Bangassé

Type of Ownership	Hectares	%
Communal Fields	41	54
Private Fields		
Wives	9	12
Unmarried children	2	3
Married Male Household Members	24	31
Elders	—	—
Total	76	100

Source: McMillan (1980), Table 14.

lage to village. The percentage of land in each tenure category for villages around Kaya were as follows: individual—36.6 percent, customary—9.8 percent, and borrowed—53.8 percent (McMillan 1980, 13).

During informal discussions, the researchers learned that lenders did not look with favor on fertilization or tree planting for fear the borrower would then claim the land. Borrowers seemed reluctant to increase the land's productivity through fertilization, use of manure, soil water, or antierosion practices for fear the lender would reclaim the land before the borrower got full payment back from his investment.

Land Cultivation and Labor

Work on collective fields takes priority over work on private fields, especially in peak labor demand periods. This requirement is strongest for younger men and women. Older men with their own households and older wives in large polygamous households have more autonomy in dividing their time between their own and communal fields. The wives of the household generally grow one plot of sorghum or millet, and one of peanuts or bambara nuts along with such crops as okra and maize. Small amounts of produce are sold in the market and the revenues are kept for personal use. During the dry season, grain from these plots must feed the women and children for at least one meal per day. Unmarried teenage children also receive small plots on which they grow cash crops, again keeping the revenue. The private plots of women and teenagers can change location from year to year.

Men within the household (brothers, sons, or cousins of the head) who are married obtain and cultivate personal land for their own use, too. They, like the household head, can give private fields to their wives and children and can require their labor. However, the married men are still

dependent on the communal fields for much of their food and are required to work in them. Some subsistence crops are grown on men's fields as are cash crops such as peanuts, bambara nuts, and cotton. The private fields of the married males usually constitute the first step in forming their own households, and the locations of the fields do not change as often as the private fields of others.

Farmer's Goals and Objectives

In responding to the on-farm decision-making questionnaire, the farmers in Bangassé and Nedogo indicated uniformly that during a given crop year their only concern is subsistence (FSU/SAFGRAD 1983, 9). This means harvesting enough sorghum and millet in November to feed their families until the beginning of the maize harvest in late August. This harvest provides food during the hungry period—the period between ending stocks and new harvest. The hungry period can be severe when ending stocks run out or are low prior to the maize harvest, or when the maize harvest is poor or late. In some years, food availability is not adequate for workers to maintain a full day's work in the field. When asked to specify other goals or objectives, the farmers reiterated their concern with survival and then listed their priorities. The first priority is the payment of the head tax. If resources remain, they meet urgent needs, which are mainly medical, reward their families with clothes for their work during the cropping season, and greet their in-laws or arrange marriages for themselves or their sons.

In Diapangou, half of the farmers gave a subsistence-oriented response that echoed the response of the farmers in Bangassé and Nedogo. However, half of the farmers said: "We were once concerned only with survival but now we think of accumulating wealth." When asked, "What is wealth?" they replied, "Cattle" (FSU/SAFGRAD 1983, 9).

Factors Affecting Cropping and Marketing Decisions

When the farmers were asked if crop prices affect cropping and marketing decisions, the common responses were, "The land tells me what to plant" and "I sell only when I have an urgent need for cash" (FSU/SAFGRAD 1983, 13). During interviews, farmers repeatedly made it clear that land quality was the dominant factor in their cropping decisions. Land quality and water retention ability are highly correlated with topography and distance from the village compound. The compound land which is in the residential area and ranges from one-tenth to two-tenths of a hectare is used to dump night soil, animal manure, stubble, and other organic material. Thus the amount of land suited to growing maize is relatively limited. At times some sorghum might be grown on the compound land, but it is largely reserved for maize and border row crops such as okra and sesame.

Sorghum is planted on the more low-lying acres where there is slightly more water accumulation and the soils are more fertile (Stoop et al. 1982, 519). Millet, which is the most drought and disease tolerant, is planted on the poorer soils. Farmers consistently said that white sorghum is highly valued because it stores twice as long (three to four years) as millet does (one to two years), however sorghum is more vulnerable to striga (a parasitic weed),[2] drought, and diseases than is millet. Farmers said that even in the worst rainfall years some millet can always be harvested. Millet could yield the same as sorghum if it were grown on the better sorghum land. Farmers also stated that the later the rains, the more millet they plant. Rice is only planted in the bottomland and in areas where water can be collected. Therefore rice fields represent a small portion of the total land area. The results of a questionnaire asking farmers the reasons for not planting more of their land to their principal cereal and cash crops are given in Table 4-7.

While farmers in Bangassé and Nedogo tended to say that price does not affect their production or marketing decisions, half of the farmers in Diapangou indicated that price is a consideration with respect to peanut planting. They indicated that, if they have already planted enough grain to meet consumption needs, a good price for peanuts would encourage them to plant more. Table 4-8 presents the percentage of crops sold by household heads during a typical year, and Table 4-9 indicates the sources of revenue used to buy grain when it is in short supply.

Farmers' Production Constraints

During the decision-making interviews, farmers were asked to identify their production constraints. In Bangassé and Nedogo, there is limited access to new land. However, farmers said that soil fertility is the limiting factor rather than the quantity of land itself. Virtually all land within the boundaries of the two villages has been cultivated continuously for the past ten years. Many fields have been planted without fallowing for as long as the farmers could remember. Traditionally, farmers planted land for five to seven years and then it was fallowed for up to twenty years to restore the fertility. This breaking down of the traditional practice of fallowing clearly has contributed to the deterioration of the already poor soil quality. Land tenure rights play an important role in the decision to fallow. Fallow land is looked upon essentially as land that can be borrowed by anyone within the clan who needs it. Since social pressures exist to lend land if it is asked for, and because population pressure has increased such requests, farmers do not fallow in land-scarce areas for fear of losing the land.

In Diapangou, farmers have relatively easy access to new land. Sorghum is generally planted for the first two years that a field is cropped

Table 4-7

Farmers' Reasons for Not Planting More of Their Principal Crops

	Bangassé (N=33)			Diapangou (N=31)			Nedogo (N=27)			Total (N=91)		
	M	S	P	M	S	P	M	S	P	M	S	P
	% of response											
Inappropriate land	—	70	—	26	74	—	—	56	—	9	67	—
Risky crop (rainfall, disease)	—	30	—	—	23	—	—	33	—	—	29	—
Insufficient labor	91	—	33	61	—	10	52	—	15	69	—	20
Competition with cereals	—	—	48	—	—	61	—	—	41	—	—	51
Other/No response	9	—	19	13	3	29	48	11	44	22	4	29

Source: Lang et al. (1983), 14.
Key: M = millet, S = sorghum, P = peanuts.

Table 4-8

Crops Sold by Household Heads, 1981–82

	Bangassé (N=34)	Diapangou (N=32)	Nedogo (N=28)
	% of available supply		
White sorghum	3.5	8.9	13.4
Millet	1.0	4.0	7.7
Peanuts	72.5	69.7	58.4
Red sorghum	—	—	27.4
Rice	33.3	—	—

Source: Lang et al. (1983), 10.

Table 4-9

Sources of Revenue to Buy Grain, 1972–81

	Bangassé (N=34)		Diapangou (N=32)		Nedogo (N=28)	
	no.	%	no.	%	no.	%
Livestock sales	21	72.4	14	60.9	16	80.0
Trades, crafts	3	10.3	3	13.0	—	—
Other	5	17.3	6	26.1	4	20.0
Total buyers	29	100.0	23	100.0	20	100.0

Source: Lang et al. (1983), 11.

and is followed by millet or a millet and sorghum association for three to four years. The land is then fallowed and new land is cropped.

Farmers were asked whether labor is a binding constraint and, if so, during which period. They reported that labor is most constraining during the first weeding of sorghum and millet, which coincides with the planting of maize, rice, and groundnuts (Table 4-10). Second weeding periods are somewhat less labor-constraining. Harvest is seldom constrained by labor availability because the rain stops well before and birds are not a problem. Farmers were also asked if they hired labor and when. Those who hire labor do so for the planting and first weeding periods, although the number hired is not a significant part of the total labor used. The wage rate is around 30 FCFA per hour. However, many farmers do not have sufficient cash reserves in these particular periods to hire labor, and the labor pool is not large. When farmers were asked why they did not hire more labor during the first weeding, their reply was, "Because there is no one to hire then, everyone is busy with their own weeding" (FSU/SAFGRAD 1983, 24).

Credit

Animal traction is the only major capital investment made by farmers in the three villages. Most animal traction units are acquired under animal traction programs with built-in credit arrangements. The access and availability of credit for agricultural inputs such as fertilizers have been studied on a limited basis (Sawadogo 1979 and Tapsoba 1981). Most formal credit is obtained through membership in a village credit group. This membership must be approved by the Organisme Regional de Développement (ORD) and the group, and a fee must be paid ranging from 500–2000

Table 4-10

Farmers' Constraints to Increased Production

	Bangassé	Diapangou	Nedogo	Total
	Number of Farmers			
Labor	24	31	24	79
Land preparation	0	1	1	2
Planting	2	0	3	5
First weeding (June/July)	21	20	12	53
Second weeding (July/August)	0	8	4	12
Third weeding/harvest	0	1	0	1
Other/No response	1	1	4	6
Land	9	0	3	12

Source: Lang et al. (1983), 25.

FCFA. The members are usually the heads of households. The degree to which economic and social factors constitute barriers to entry into the village credit groups is not known. This form of credit was administered by the regional ORD with financing usually provided by the Caisse Nationale de Credit Agricole. The interest rate is subsidized and set at 5.5 percent. In cotton-growing areas, the Société Voltaique des Fabres Textiles (SOFITEX) is an important source of credit. The formal credit market is usually not open to the members of the household other than the head. When farmers were asked why they do not purchase fertilizer, their answer was that it is not readily available and that they lack the credit. The informal credit market is very active. At times it is used for purchased farm inputs, but it is mainly used for nonagricultural purposes such as food, clothing, and family obligations. Annual interest rates in the informal market are high and range from 200–250 percent.

AVAILABLE RESEARCH STATION TECHNOLOGIES

Cultivation Practices

During the diagnostic phase the FSU team surveyed the available research station technologies. Earlier research included on-station experiments showing gains in yield from timely planting, seeding in rows, and better and more timely weeding. There were studies of the water retention technique of tied ridging in Africa starting in the 1960s (Dagg and Macartney 1968). Although ridges were traditional in most of the farming systems on the Mossi plateau, the tying of the ridges was not. Tied ridging decreases rainfall runoff, allowing for increased water infiltration. The technique of tied ridging is discussed in Appendix 4-C.

Fertilization

Recommended fertilizer rates are presented in Table 4-11. The 14–23–15 fertilizer was known as cotton fertilizer or SOFITEX because it was specifically mixed and distributed by SOFITEX for cotton production, and it was the most readily available commercial fertilizer in Burkina Faso. Small amounts of sulfur and boron are included in 14–23–15. The results typical of fertilizer experiments carried out by several organizations are summarized in Table 4-12. Also available is the local Volta phosphate (VP1) which is P205 rock phosphate in powdered form. VP1 has a chemical composition such that the phosphate available to the plant is released slowly over time. Depending on the soil, VP1 requires several months to several years before it is available to the plant and thus the carry-over from one year to the next can be very high (as high as 67 percent; World

Table 4-11

Commercial Fertilizer Recommendations, 1980

Crop*	SOFITEX + Urea		Volta Phosphate + Urea	
	14–23–15**	46–0–0	0–24–0	46–0–0
	kg/ha			
Sorghum	100[a]	50[c]	200[a,k]	50[e]
Millet	100[a]	50[c]	200[a,k]	50[e]
Maize	100[a]	100[f]	300[a,k]	100[e]
Groundnuts	100[b]	0[j]	250[a,k]	0[j]
Cowpeas	100[b]	0[j]	—[k]	0[j]
Sesame	100[b]	0[j]	—[k]	0[j]
Rice	100[a]	50[d]	200[i,k]	50[d]
Cotton	150[a]	50[f]	—[k]	50[f]
Soybeans	150[a]	50[b]	—[k]	50[b]
Forage legumes	100[a]	0[j]	—[k]	0[j]
Forage grasses	100[a]	50[g]	—[k]	50[g]

Source: Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT) (1980).

*Fertilizer application is in seed pocket or banded at seeding. Urea is applied in a pocket or banded 10–15 cm from the plant and always covered immediately. Timing for various crops is as follows:

[a]Application at seeding

[b]Application at seeding or 10–15 days after seeding

[c]Application at first growth

[d]Application at tillering

[e]Application at 20–30 days after seeding

[f]Application at 30–40 days after seeding

[g]Application at 40 days after emergence

[h]Application at flowering

[i]125 kg/ha at seeding, and 75 kg/ha at panicle emergence

[j]Recommended 50 kg/ha 0–0–60 (potassium chloride) at seeding

[k]General recommendation for all crops of 400 kg/ha in the first year, and 100 kg/ha in each following year

**Actual formulation of SOFITEX is 14N–23P–15K–6S–1B_2O_3.

Bank et al. 1983, 213). Experimental results using VP1 were not comprehensive and were still inconclusive with respect to its impact on yield and the dose that should be used. The 1981 fertilizer farm prices (subsidized) were 45, 60, and 20 FCFA per kilogram for 14–23–15, urea, and VP1 respectively. The fertilizer price subsidies were 61 percent, 50 percent, and 72 percent respectively (Haggblade 1984).

Varietal Improvements

Despite research on varietal improvement conducted by IRAT, IITA, and ICRISAT, and several tests made on-farm by FSU and ICRISAT, there was little improved material ready for extension to farmers. Experimental re-

Table 4-12

Yield Response Rates for Fertilizer

Crop	Yield Response	Fertilizer	Remarks
	kg/ha	(N–P–K)	
Millet	240	37–23–15[b]	Average 1976–79 on-station, Saria, IRAT
Millet	111	14–23–15[a]	Generalized on-station, estimate, IRAT
Sorghum	900	37–23–15[b]	Average 1976–79 on-station, Saria, IRAT
Sorghum	600	37–23–15[b]	Saria, IRAT, 1979
Sorghum	300	37–23–15[b]	On-farm, Saria, IRAT
Sorghum	75	14–23–15[a]	Northern Burkina, Yatenga, 1979, IRAT
Sorghum/Millet	295	18–24–00[f]	On-farm researcher-managed, FSU/SAFGRAD, 1979
Sorghum/Millet	0	00–36–00[g]	On-farm researcher-managed, FSU/SAFGRAD, 1979
Maize	1,575	60–23–15[c]	Average 1977–79, on-station, Farako-Ba, IRAT
Maize	1,410	60–23–15[c]	On-station, Farako-Ba, 1979, IRAT
Cotton	630	44–35–15[d]	On-station, Saria, IRAT
Cotton	515	44–35–15[d]	Average 1976–79, on-station, Saria and Farako-Ba, IRAT
Peanuts	150	14–23–15[a]	Average 1976–79, on-station, Saria, IRAT
Soybeans	870	44–35–15[d]	Average 1978–79, on-station, Farako-Ba
Paddy rice	450–875	46–00–00[e]	Project Phosphate

Source: World Bank et al. (1983), 213.
Note: 14–23–15 and rock phosphate applied at or within two weeks of planting. Urea applied one month after planting.
[a]100 kg/ha 14–23–15
[b]100 kg/ha 14–23–15 plus 50 kg/ha urea
[c]100 kg/ha 14–23–15 plus 100 kg/ha urea
[d]150 kg/ha 14–23–15 plus 50 kg/ha urea
[e]100 kg/ha urea
[f]100 kg/ha rock phosphate (24% solubility) plus 40 kg/ha urea, first year of application
[g]150 kg/ha rock phosphate (24% solubility), first year of application

sults from the 1981 Regional Cowpea Variety Trials are presented in Table 4-13. These were the varieties recommended by IITA to SAFGRAD for on-farm testing for the 1982 field campaign. The major focus of the IITA cowpea breeding program was to incorporate resistance to insect pests (SAFGRAD 1981, 38). However, the varieties listed in Table 4-13 were susceptible to insect infestations and required spraying with an insecticide

Table 4-13

IITA Regional Cowpea Variety Trials, 1981

Varieties[a]	Farako-Ba (Bobo)	Kamboinse (Ouagadougou)
	kg/ha	
TVx 1999	1,211	1,862
Gorom local (SUVITA-2)	984	1,948
KN-1	1,468	1,541
TVx 3236	1,244	1,901
Local check	1,227	12[b]
Trial mean	877	1,225
L.S.D.	446	385
C.V.%	35.9	22.1
Rainfall (mm)	1,148	700

Source: Excerpted from IITA Annual Report, Burkina (1981), Table 14.
[a]Three or four insecticide applications starting at flowering stage
[b]Fusarium wilt problem

(annual capital cost of 800 FCFA per hectare for the sprayer and 500 FCFA per hectare per insecticide treatment). As yet, cowpea diseases were not a major problem.

The major objective of the IITA maize-breeding program was to develop high-yielding, early- and medium-maturing varieties and populations tolerant to the environmental stresses of the semiarid region (SAFGRAD 1981, 7). Several promising varieties identified in regional trials, SAFITA-1, SAFITA-2, SAFITA-102, and SAFITA-104, were recommended for further testing. They are early- and medium-maturing and yield on average as good as or better than local checks, depending on the environment. Yield gains of up to 2,400 kilograms per hectare (74–23–15 kilograms per hectare fertilizer) were observed on some IITA on-station trials (SAFGRAD 1981, 9). However, further testing was required.

ICRISAT developed the sorghum variety E 35-1, and on-station experimental results showed average yields of up to 3500–4000 kilograms per hectare under ideal management and fertility conditions (ICRISAT 1979 and 1980). Table 4-14 presents results from an IRAT trial. To date, there were no improved millet varieties available for the area, and little research had been done on forage and pasture improvement in the central plateau.

After reviewing this material, the FSU team constructed a calendar of the agricultural, livestock, and other production activities undertaken during the year and discussed the resources available to different farm households and individuals.

Table 4-14

Sorghum Yields at Saria, 1980

Treatment (N–P–K)	Sorghum Varieties E35-1	S6[a]
	kg/ha	
Control (0–0–0)	456	448
37–23–14	1,324	729

Source: IRAT (1981), 14.
[a]The control is S6, a variety similar in yield response to local varieties.

STUDY QUESTIONS

1. What and when are the agricultural, livestock, and other production activities carried on during the year and who does them?
2. What factors affect men's and women's access to and control of resources for production? What factors affect men's and women's access to and control of benefits from production?
3. What are the constraints and priority problems faced by farmers when attempting to increase agricultural production? What technological interventions might be considered?
4. List the possible technological interventions and associated field trials or experiments that you might want to consider in designing a field program. Define the domain (region, types of farmers and individuals, etc.) in which you will work, the time frame, and the method of organizing the program, i.e. the sequencing of researcher- and farmer-managed trials.

NOTES

1. The discussion on land tenure and the rights to cultivation in this section were based largely on the studies of McMillan (1980), Henderson et al. (1982), and Saunders (1980).

2. *Striga hermonthica* (Del.) Benth. is a parasitic weed which attacks sorghum and is commonly known as striga.

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Appendix 4-A: Background Information on Burkina Faso[1]

Physical Features

Burkina Faso is a landlocked country in the center of West Africa and is bounded by six nations (Figure 4-1). Ouagadougou, the capital, is connected by rail with the deep water port of Abidjan, Ivory Coast, and by all-weather roads to Lome, Togo, and Accra, Ghana. The rivers in the Volta basin, which drain most of the country, are the three Voltas (Noire, Rouge, and Blanche). With the exception of the Volta Noire, the water flows are small and at times intermittent, especially in the dry season. At present, there are about 10,000 hectares being irrigated out of an estimated 125,000 hectares that could be irrigated with full water control. However, the intermittent water flows, the presence of onchoceriasis (river blindness) in many of the river valleys, and the high cost of irrigation makes new irrigation projects hard to justify on an economic basis.

The soils of Burkina Faso are in general of poor quality and consist of shallow, poorly structured alfisols. More productive vertisols and hydromorphic soils are found along river valleys mostly in the southwestern part of the country. Burkina Faso is not rich in mineral deposits, but it has significant but low-grade rock phosphate deposits in the southeast.

Climate

Burkina Faso is situated in the zone known as the semiarid tropics. The climate is primarily Sudanian, with the exception of the northeast which is Sahelian. Harmattan conditions (hot, dry, dust-laden winds) exist during the dry season. Since the midsixties, annual rainfall has averaged 100–150 millimeters below the long-term average within each rainfall zone. The average rainfall is represented in Figure 4-1. Because rainfall generally arises from convective storms, rainfall patterns are unpredictable. Rainfall patterns during the May–October rainy season are highly variable from year to year at any one location. Rainfall also tends to be very spotty, resulting in adjacent locations having very different rainfall levels and patterns. Thus drought conditions can occur in some locations while the rest of the country has rain. Desertification in the northern area and drought are real concerns.

Demography

Most of the population lives on a plateau in the central part of the country referred to as the Mossi or Central Plateau. About 90 percent of the population in Burkina Faso lives in rural areas, with 83 percent of the labor force engaged in agriculture. The infant mortality rate in 1982 was 185 per 1,000 and life expectancy was forty-two years. The population of Burkina Faso is comprised of two major West African groups: The Voltaic and the Mande. The Mossi and the Bobo make up the majority of the Voltaic group. The Mossi ethnic group makes up about one-half of the population and is the dominant group in both political and economic life in Burkina Faso. The Fulani, who are transhumant, also lived in the area. French is the official government language and is taught in the schools; however, most of the people speak in their own tribal languages in the countryside. Burkina Faso is the largest supplier of emigrant workers in West Africa, estimated to be 25 percent of its work force, and these are mainly the better-educated young single men.

Regions

Based on population density, rainfall, vegetation, and access, Burkina Faso can be divided into four regions: southwest, Central (Mossi) Plateau, eastern savannah, and the Sahel. The southwestern region, because of its more favorable climate, rainfall, water resources, soils, population density, and access to markets, has the most potential for economic expansion and agricultural intensification.

The FSU team was working in the Central Plateau. The Central Plateau has poor and eroded soils, a high population density, and few permanent water courses or bottomlands. This region has a road network and includes the capital, Ouagadougou, which is the major consumption center. Potential does exist for agricultural intensification, but prospects are not nearly as good when compared to the southwestern region.

Economy

Burkina Faso is one of the poorest countries in the world. Over 90 percent of the population are engaged in farming and livestock production. The chief subsistence crops are millet, sorghum, and maize. Cash crops include cotton, shea nuts *(karate)*, peanuts, and rice. Small ruminants and cattle are used as a source of meat and as a store of wealth. They also are used in risk management. The country is one of Africa's least industrialized nations. Burkina Faso has a large textile factory, a

sugar plantation and refinery complex, and a brewing industry. Several smaller factories produced light industry goods for in-country consumption, including a farm machinery manufacturing plant in Ouagadougou.

NOTE

1. The background information on Burkina Faso is a synthesis of several publications: World Bank et al. (1983); Jaeger (1985); United States Department of State (1984). (See Case References.)

Appendix 4-B: Research and Policy Institutions in the Agricultural Sector

Research Institutions

Between 1960, the year of independence, and 1977, agricultural research in Burkina Faso had been carried on by means of bilateral agreements with France, agreements with international research institutes, and the forging of national research institutions. During this period, the Ministry of Rural Development, through its agricultural research service, was in charge of research policies and the coordination of the various research organizations. However, agricultural research services remained small and uncoordinated and, outside of the cotton region, extension services were poor. This was the setting in which SAFGRAD was organized and started in 1977.

SAFGRAD is a regional research coordinating program implemented by the Coordination Office of the Scientific, Technical and Research Commission of the Organization of African Unity (OAU/STRC). The SAFGRAD project works in cooperation with twenty-six countries, and the coordination office is located in Ouagadougou. SAFGRAD is funded by USAID, the International Fund for Agricultural Development (IFAD), and French Aid for Cooperation (FAC).

To carry out its mandate, SAFGRAD promotes the exchange of improved plant materials and technical information among member states through regional testing, workshops, and monitoring tours. The program strengthens national agricultural research programs through short- and long-term training, seminars, and research inputs. The promotion of the diffusion and transfer of on-farm adaptive technology is also supported.

SAFGRAD collaborates directly with IITA and ICRISAT. Many of these research programs are conducted at the principal agricultural research station at Kamboinse in Burkina Faso. Another component of SAFGRAD is

the Accelerated Crops Production Officers (ACPO) program, which conducts on-farm preextension and demonstration trials. An integral part of the program is farming systems research, which provides linkages between on-station research and the ACPO extension programs. The design of SAFGRAD permits the flow of research information from component researchers (IITA, ICRISAT, and IRAT) to a farming systems unit (FSU) to the ACPOs and on to the host country extension program, while allowing for interaction among the groups.

Parastatal Organizations

The Office Nationale des Céréales (OFNACER), a public cereals-marketing agency, was established by the government of Burkina Faso to ensure producer incentives, protect consumer income, and promote regional equality. The effect of OFNACER is limited by insufficient financial resources to carry out its mandate, and it mainly relies on food aid to stock its warehouses.

SOFITEX (Société Voltaique des Fibres Textiles) markets all the cotton production and provides input, primarily to the cotton farmers. It serves other farms and other crops as well.

Extension

The Organismes Regional de Développement (ORD) are agencies responsible for carrying out rural development programs and the promotion of agriculture. FSU worked directly through the ORD agent or office to establish research with local farmers. The ORD agents were involved, mostly by visiting the plots and communications with the local FSU field staff, in the research and in maintaining relationships with the villagers. The ACPO program was largely inactive during the early years of the project, particularly in Burkina Faso.

Appendix 4-C: Tied Ridges[1]

The technique of tied ridges consists of making embankments at regular intervals between ridges, thus creating basins for water microcatchment. This technique makes it possible to reduce runoff from the plot and to make more rainwater available to the crop.

Tied ridging changes the land between the planted rows in two ways. The first change is ridging or mounding, in which the soil is banked up against the crop row to create a depression between the rows. The second is "tying," which makes embankments perpendicular to the ridges (see Figure 4-C.1). The effectiveness of the tied ridge depends on numerous factors: (1) distance between the ridges, (2) date of ridging or of tied ridging, (3) nature of the soil, and (4) position on the toposequence.

Concerning the relationship of tying to plant establishment, tying may be introduced in several ways:

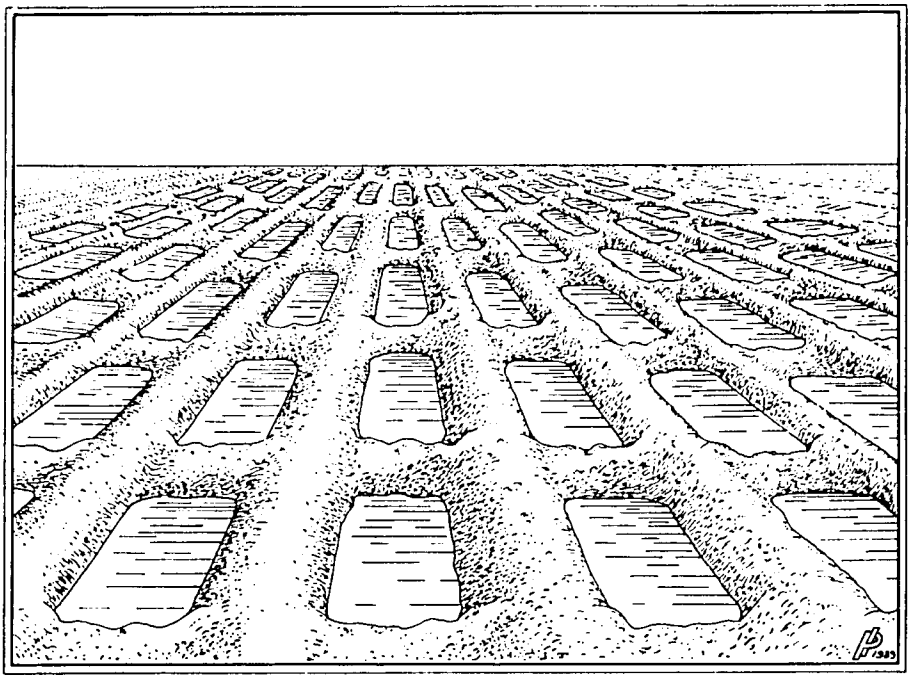
1. By establishing the tied ridges first, followed by direct seeding on the ridges, manually or mechanically. In this case, soil tillage has no effect on crop root establishment.

2. By flat seeding after land preparation, followed by tied ridging about three weeks to one month after seeding.

3. By flat seeding, mounding at the beginning of plant growth, and tying some time afterwards.

Figure 4-C.1

Tied Ridges



The effectiveness of the tied ridge will then depend upon the distribution of rains with respect to the date of tying and also upon the nature of the soil. If the soil is too sandy, the tied ridge might not resist severe rains and it will be necessary to bank it up regularly (hence additional work). It is therefore preferable to perform tying rather late, so that it can be effective at the period of ear emergence or flowering, a very stress-sensitive period of plant growth. On the other hand, if the soil is clayey enough and if the tied ridge is solid, it is preferable to make it early. If one wishes to utilize all of the water of the soil profile by deep root establishment, it is better to plough beforehand. The IITA-SAFGRAD experiment has shown that in clayey soils the tied ridges could be kept for two years without being banked up. Of the total cultivated area of 2,005,000 hectares in Burkina Faso, it is estimated by local agronomists that about 40 percent is suitable for tied ridging, based on land quality and rainfall levels.

Tied ridges can be built either by hand tillage or with a combination of animal traction and hand tillage. If done by hand tillage, depressions (32 centimeters long by 24 centimeters wide by 16 centimeters deep) are made between the rows and are spaced 1.5 meters apart. If done with animal traction, the cultivator must be equipped with a middle sweep to create a furrow, then it is followed by hand tillage to make a 16-centimeter high ridge perpendicular to the furrow, every one to two meters. In practice, the catch basins of the manually tied ridges are more shallow and are spaced further apart, thus resulting in less water-holding capacity than those made when the rows are first ridged with animal traction and then tied.

NOTE

1. Adapted from R. Nicou and C. Charreau (1985), 24–27. (See Case References.)

Figure 5-1
Map of Colombia Showing CIAT and the Research Site, Pescador

Chapter 5

Colombia

Production and Consumption Aspects of Technology Testing in Pescador

JACQUELINE A. ASHBY

CONTENTS

Part 1 Initial Diagnosis and Planning
Early Consultations
Key Informant Interviews
Formal Questionnaire
Innovative Farmer Survey
Study Questions
Note

Part 2 Experimentation, Ongoing Diagnostic Research, and Evaluation
Experimentation
Participant Observation
Evaluation
Study Questions

Part 3 Findings and Future Research (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

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Colombia: Part 1
Initial Diagnosis and Planning

EARLY CONSULTATIONS

One morning in December 1984 a group of senior scientists on the research staffs of the Centro Internacional de Agricultura Tropical (CIAT)[1] and the International Fertilizer Development Center (IFDC) met to plan activities for the February planting season, which would launch a new project on Farmer Participation in Technology Assessment. The project members aimed to implement participatory research that would involve small farmers in the assessment of agricultural technologies.

The objectives of the participatory approach were to integrate farmers' management strategies and criteria for identifying acceptable innovations into the project's identification of promising technologies. This would involve farmers directly in the planning, execution, and evaluation of farm trials. By establishing a dialogue process with farmers about what should be tested, how it should be tested, and what conclusions should be drawn from the results of testing, the project members hoped to demonstrate that client (farmer) participation in agricultural technology development was a feasible and efficient technique for fine-tuning adaptive research to address farmers' location-specific circumstances and needs.

This approach had evolved after ten years of research in which promising recommended varieties of crops had had a mixed record of adoption. Follow-up studies had shown that nonadoption was related to very specific characteristics of the varieties such as an unacceptable two-week delay in harvest. The participatory approach was intended both to provide earlier and more specific information to breeders and to minimize nonadoption.

The purpose of the meeting was to identify which varieties among many improved varietal materials of the CIAT bean-breeding program might be included in the project, along with promising new fertilizer technologies developed by the IFDC phosphorus research program.

The group included a soil scientist, a breeder, an agronomist, and two social scientists—an economist and a sociologist. All shared a concern in developing on-farm research methodologies to assist national agricultural research programs in their development of improved production technology for small farm systems, an important component of the mandate of International Agricultural Research Centers.

COLOMBIA	
Area	1,139,000 km^2.
Population	26.7 million (mid-1980s); growth rate 2.0%. 69% urban, 31% rural; 98% live in 45% mountainous area.
Income	GNP/Capita: U.S. $1,180 (1980). Sources: agriculture (28%); major exports are coffee and oil.
Agroecological features	Western one-third, mountainous; characterized by narrow valleys and isolated basins with distinctive soil conditions.
Agriculture	Four percent of the land cultivated; average farm size 2 ha. Leading crops: maize, wheat, rice (in acreage).
Climate	Extreme variation from hot, damp lowlands to temperate highlands.
Currency	Peso. Col $190 = U.S. $1.

CALDONO, CAUCA, COLOMBIA	
Area	444 km^2.
Population	16,000 persons, 96% rural; Pescador has 3,000 persons.
Income	Sources: farming, temporary migrant labor in agriculture, construction, mining.
Rainfall	2,000 mm/yr; bimodal with wet seasons March–June; September–November.
Elevation	1,300–1,800 m above sea level.
Temperature	Mean 18° C.
Soils	Clay, acid, low in phosphorus.

The sociologist presented to the group a general summary of the socioeconomic characteristics of farms taken from an existing survey of a small farm system in Pescador, located in the municipal district of Caldono. Pescador is the collective name for several rural subdivisions of Caldono which share a common church, secondary school, and health post. In Pescador farms were small, owner-operated family concerns; farming of coffee and cassava, the principal crops, was cash oriented; and, while beans were not a major crop, most farmers grew some beans for sale (see Tables 5-1 and 5-2). Moreover, small farmers were intensifying production, as evidenced by the rapid adoption of relatively new crops in the farming system, such as bush beans and tomatoes, in the past three years. Use of fertilizers was correspondingly becoming widespread, particularly on new crops such as bush beans, due to the poor quality of the soils.

The soil scientist supported the feasibility of the site, presenting data on soil chemical analysis and yield response of beans to phosphorus at this site (see Figure 5-2). These data showed acid soils very low in phosphorus which indicated promising conditions for testing rock phosphate fertilizer materials of the IFDC phosphorus research program (see Table 5-3).

Table 5-1

Farm Size Distribution

Farm Size	Distribution of Farms (%)
Large (> 15 ha)	16
Medium large (10–15 ha)	23
Medium small (5–10 ha)	21
Small (< 5 ha)	40
Total	100

Table 5-2

Land Use

Use	Avg. Land Area (ha)
Coffee	1.56
Cassava	1.75
Beans	0.33
Other minor crops	0.22
Pasture/Fallow	5.16
Average farm size	9.02

Table 5-3

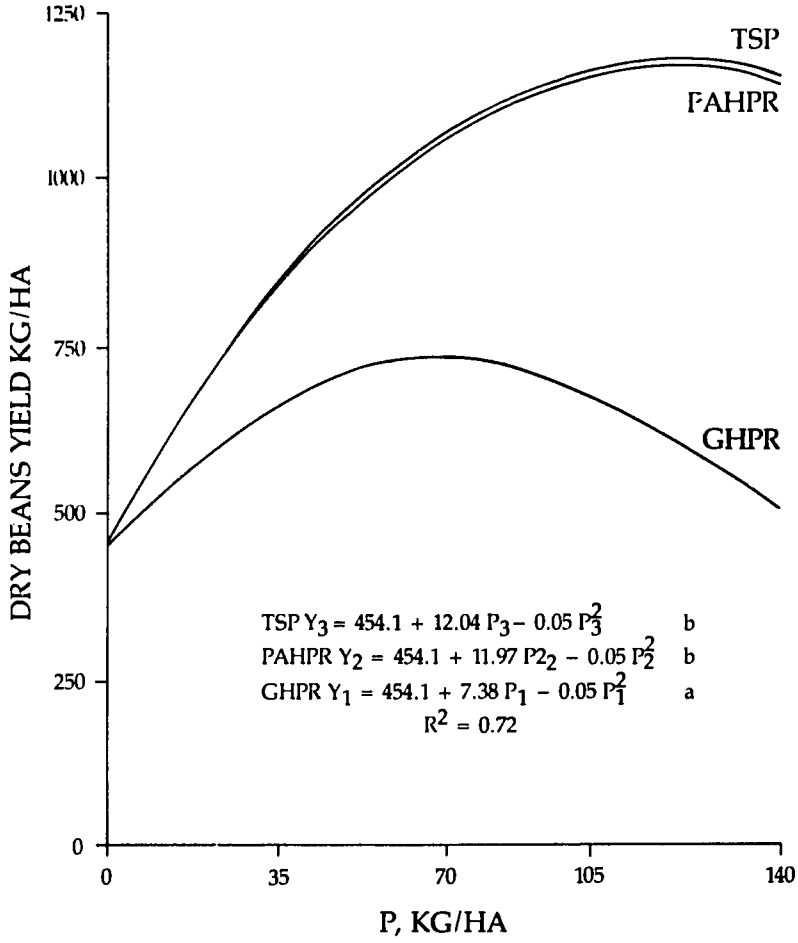
Chemical Analysis of Soil Samples *(N=46)*

Soil Properties	Range	Percent of Samples
Pppm (Bray II)	0.10 – 1.50	53
	1.50 – 3.30	47
K meq/100 g	0.10 – 0.15	37
	0.15 – 0.35	63
Organic matter (%)	3.70 – 10.00	63
	10.00 – 20.00	37
Aluminum saturation (%)	26.70 – 50.00	37
	50.00 – 93.00	63
pH	4.40 – 5.00	63
	5.00 – 5.30	37

The group discussed what type of bean varieties farmers in this system might be most interested in. The breeder asked whether climbing beans or bush beans would be the most appropriate. The agronomist wondered what farmers' interests were in intensive versus minimum input

Figure 5-2

Response of Beans to Phosphorus Sources and Rates, 1982



TSP = Triple Super Phosphate
PAHPR = Partially Acidulated Huila Rock Phosphate
GHPR = Ground Huila Rock Phosphate

Note: Beans were grown in fourteen sites in Pescador as the first crop. Pairs of response functions with the same letters are not significantly different at the 0.05 level of significance.

management of the bean crop. The economist asked what farmers' preferences were as to bean grain types. Small farmers in Colombia were producing beans as a cash crop for the consumption of a rapidly urbanizing population with specific cultural preferences for a large red opaque-type

bean. In view of the importance of grain size in determining bean prices, it would be significant to test varieties which had high probabilities of acceptance in the market and higher prices than less preferred grain types.

The breeder pointed out that the central objective of the bean breeding program was to breed high-yielding disease resistant varieties. It had proved problematic to combine high-yielding characteristics with the preferred large red opaque grain type for varieties adapted to the altitude and climatic conditions of the proposed research site. For this reason, the program's improved varieties that adapted to the agroclimatic zone tended to be somewhat inferior in grain type to the currently available varieties grown by small farmers in Colombia. However, the breeder identified ten promising materials which he ranked in order of acceptability (see Table 5-4).

The social scientist proposed that the first step in the farmer participation methodology would include asking farmers to evaluate samples of the grain types and to select, from among these ten varieties, three or four that were acceptable. Then farmers could evaluate these varieties in field trials.

In view of the short time available for planning experiments for the February planting season, the group decided to go to the field with a rapid diagnostic survey that would describe bean cultivation practices in the proposed site and answer some of the questions raised in the group.

KEY INFORMANT INTERVIEWS

In early January, a field research team consisting of the social scientists and the agronomist began this diagnostic research by conducting informal interviews with key informants who were experienced bean farmers in

Table 5-4

Breeder's Ranking of Ten New Bush Bean Lines and Varieties in Terms of Likely Acceptability to Farmers

Rank	Bean Variety	Grain Size and Color
1	A-36	Medium, red opaque
2	A-486	Large, pink opaque
3	AFR-205	Large, purple mottled
4	HORSEHEAD XYC 206	Small, red opaque
5	ANTIOQUIA 8L-40	Small, red opaque
6	G 7223 x BAT-1276 C	Small, red opaque
7	PVAD-1261	Medium, red opaque
8	G 4453 x BAT-1386 C	Small, red opaque
9	ANCASH - 66	Medium, white
10	BAT-1297	Very small, red opaque

Note: Rank 1 = most acceptable; 10 = least acceptable.

Pescador. They soon identified a list of farmers who included beans in their cropping system. The initial key informant interviews very quickly indicated that there was a division of labor in the farming system between field crop production activities carried out by men and domestic activities carried out by women and children. For example, when the researchers visited farms, children often led them to the fields to interview men. When interviewed at home, men took the leading role in the informal interviews. Women disappeared into the kitchen to prepare food and drink for the visitors.

FORMAL QUESTIONNAIRE

A formal questionnaire on bean production activities was administered to forty male heads of household. The responses were quickly tabulated to provide a picture of farmers' current bean production technology. The survey results showed that the large red opaque grain type was the most commonly grown, whether of bush or climbing bean varieties (see Table 5-5). The results also showed that climbing beans were grown mainly in subsistence-oriented systems intercropped with maize and that fertilizer practices for climbing beans were different from those for bush beans (see Table 5-6). Bush beans were monocropped mainly as a cash crop, although most farmers retained part of the harvest for seed and household consumption purposes. All farmers applied fertilizer to bush beans.

The rapid diagnostic survey found that 50 percent of farmers applied chicken manure using a standard measure of a tinful *macarela* in each planting site. Chicken manure was sold locally in 50-kilogram bags at a price of Col $230 per bag, delivered at the farm gate by vendors who pass through the area with truckloads of manure obtained from industrialized chicken producers located nearby. Another 35 percent of farmers customarily applied smaller quantities of chicken manure, measured in handfuls, and in some cases farmers were experimenting with handfuls of chicken manure mixed with a compound fertilizer, 10–30–10 (see Table 5-7).

Although the standard practice used for planting was two to three seeds per planting site, farmers considerably varied the distances between planting sites, which they related to the fertility of the plot and the type of land preparation (see Table 5-8). As a result, fertilizer rates varied, ranging from as little as 1,000 kilograms per hectare of chicken manure to more than 5,000 kilograms per hectare. However, the most common practice of applying a tinful of chicken manure at a planting distance of 60 centimeters between planting sites and 80 centimeters between furrows or rows gave an estimated rate of 5,000 kilograms per hectare of chicken manure, at a cost of Col $23,000 per hectare. Farmers universally stated that without fertilization, bush beans could not be grown in the region. The avail-

Table 5-5

Bean Varieties Grown by Farmers *(N=40)*

Bean Variety	Size and Color of Grain	% of Farmers Growing Variety
Bush beans		
Calima	Large, red opaque	62.9
Cuarzo Rayado	Large, red opaque	24.2
Cuarzo Rojo	Large, red brilliant	6.9
Cuarzo Amarilli	Large, yellow opaque	6.0
Total		100.0
Climbing beans		
Sangre Toro	Large, red brilliant	45.8
Cuarzo de Vara	Large, red brilliant	10.4
Revoltura	Mixture of types	20.8
Miscellaneous	Also found in mixtures	23.0
Total		100.0

Source: Formal Questionnaire, Diagnostic Survey, Pescador, Colombia (1984).

Table 5-6

Farmers Using Fertilizer on Bush and Climbing Beans *(N=40)*

Fertilizer Type	Climbing Beans %	Bush Beans %
Chicken manure	25.9	74.1
10–30–10	21.2	0.0
Chicken manure/10–30–10 mixed	0.0	22.2
Farmyard manure	4.7	3.7
Other chemical fertilizer	4.8	0.0
No fertilizer used	43.4	0.0
Total	100.0	100.0

Source: Formal Questionnaire, Diagnostic Survey, Pescador, Colombia (1984).

ability of chicken manure had increased in the five years prior to the diagnostic survey, and this innovation appeared to have stimulated plantings of bush beans in the area.

INNOVATIVE FARMER SURVEY

Concurrently with the survey research activities, the field research team implemented the farmer participation methodology. Key informants were asked to identify a group of farmers among bean farmers in Pescador

Table 5-7

Quantities of Fertilizer Applied to Bush Beans *(N=40)*

Fertilizer	Application Rate per Site	Measured Equivalents N	P	K	Cost
		kg/ha			Col $/ha
Chicken manure	1 tinful	315	14	129	23,000
Chicken manure	1 handful	236	8	97	17,250
Chicken manure	1/2 handful	118	4	48	8,625
Chicken manure + 10–30–10	1/2 handful + 1 pinch	145	39	71	15,300

Source: Formal Questionnaire, Diagnostic Survey, Pescador, Colombia (1984).

Table 5-8

Distances Between Planting Sites for Bush Beans *(N=40)*

Distances	Percent of farmers using
80 cm	8.7
70 cm	4.3
60 cm	26.1
50 cm	8.7
40 cm	21.7
30 cm	8.7
25 cm	8.7
20 cm	8.7
10 cm	4.3
Total	100.0

Source: Formal Questionnaire, Diagnostic Survey, Pescador, Colombia (1984).

who were known in the community to be experimenting with different ways of growing beans. The sociologist and agronomist interviewed these sixteen innovative farmers about their objectives in growing beans: what aspects of bean production were they attempting to improve, and why? The farmers were shown the samples of the ten new bean varieties and were asked to select six what they would be interested to try with respect to grain type. Each farmer ranked six preferred grain types in order from most to least preferred.

The researchers made a content analysis of the open-ended discussions with the group of innovative bean farmers about their production practices. The farmers had expressed a concern toward cutting the high costs of fertilizer entailed by growing bush beans on their poor soils. Traditionally, the more fertile plots were reserved for climbing beans. Farm-

ers were attempting to cut bush bean production costs by mixing purchased chicken manure and chemical fertilizers and applying these mixtures at reduced rates. At the same time, some were increasing labor inputs to production, primarily by spraying their bean crop with greater frequency to control pests and disease. Some farmers expressed interest in disease-resistant varieties that would require less spraying; others said they did not care about the extra work as long as the varieties of beans had a superior grain quality for the market.

The innovative farmers' ranking of the ten bean varieties was tabulated (see Table 5-9). While farmers appeared less concerned with grain color than expected, the results confirmed the judgement of the breeder that large grain types would be preferred, with one surprising exception. The very small red opaque type, BAT-1297, was ranked overall in sixth place. As they reviewed the interviews on a case by case basis, the researchers found that in several instances BAT-1297 had been ranked as high as third place. They tried to recapture what had occurred in the interviews to produce this deviation from the normal range of preferences, and realized that these interviews took place in situations where both the husband and wife had examined the grain samples—often because the discussion had occurred at the farmhouse instead of in a meeting in one of the fields. Interview notes showed that some women had claimed to recognize the very small red grain as a traditional variety which had disappeared from the locality, but which was high yielding and very flavorful.

Table 5-9

Innovative Farmer Evaluation of Grain Quality of New Bush Bean Lines *(N=16)*

Bush Bean	Size and Color of Grain	No. of Farmers Selecting Type[a]	Total Score[b]
AFR-205	Large, purple mottled	16	68
A-486	Large, pink opaque	14	56
A-36	Medium, red opaque	13	51
ANCASH - 66	Medium, white	12	46
PVAD-1261	Medium, red opaque	8	28
BAT-1297	Very small, red opaque	7	21
G 4453 x BAT-1386 C	Small, red opaque	7	19
HORSEHEAD XYC 206	Small, red opaque	8	19
G 7223 x BAT-1276 C	Small, red opaque	7	18
ANTIOQUIA 8L-40	Small, red opaque	4	10

Source: Innovative Farmer Interviews, Pescador, Colombia (February 1985).

[a]Farmers were asked to select six preferred grain types out of the total ten proposed for on-farm trials.

[b]Each farmer ranked his six preferred types in order from most preferred (score = 6) to least preferred (score = 1).

As the February planting season fast approached, the field research team of the project sat down with their colleagues to review the information they had obtained from diagnostic research. They concluded that one objective of on-farm experimentation for testing new bean varietal materials and rock phosphate fertilizers should be to follow up on farmer experimentation with fertilizer mixtures. They saw a need to evaluate varietal-fertilizer interactions utilizing mixtures of rock phosphate with other nutrient sources, including the chicken manure purchased locally by farmers. The soil scientist had been evaluating a large number of fertilizer mixtures on-station in greenhouse experiments, and proposed testing different dosages of one of the potentially most promising of these mixtures in an exploratory on-farm trial. A minimum dosage of the proposed mixture applied at the research station was 1,153.8 kilograms per hectare made up of 195 kilograms of rock phosphate, 945 kilograms of chicken manure, and 15.6 kilograms of sulfur. In order to plant trials in February, the soil scientist wanted to use monocropped bush beans as the test crop because climbing beans could not be planted until September.

The researchers identified two types of farmer management strategy from the results of the diagnostic research. They suggested that, given the potential of the new bean varieties for improved disease resistance, it would be important to evaluate varietal-fertilizer interactions under representative farmer management conditions for the control of pest and disease problems as shown by the rapid diagnostic survey. Moreover, most farmers expected less disease stress in the second planting season, August/September, so it would be important to repeat evaluations in both planting seasons. The interviews with innovative farmers, which were intended to provide scope for farmer input into how new technology was tested, had indicated that some farmers were adopting more intensive methods of pest and disease control. The researchers recommended that this level of management be included in the trials.

In choosing which bean varieties to test, the agronomist and soil scientist preferred to include only one or two varieties in order to keep the trials simple. However, farmer participation in the selection of preferred grain types during the initial diagnostic research had produced an intriguing result: an apparently unattractive small grain type, BAT-1297, had been selected by some farmers.

The sociologist argued that the selection of BAT-1297 when women took part in these discussions was potentially an important clue to the existence of a broader range of preferences than were being tapped by the interviews with farmers who were male heads of household. The social scientists and agronomist had retabulated the miscellaneous category of bean varieties identified in the rapid diagnostic survey and had found that a diversity of grain types were in fact grown in the semisubsistence-oriented, climbing-bean production system of Pescador (see Table 5-10). Apparently

Table 5-10

Retabulation of Bean Varieties Grown by Farmers *(N=40)*

Bean Variety	Size and Color of Grain	Percent of Farmers Growing Variety
Bush Beans		
Calima	Large, red opaque	62.9
Cuarzo Rayado	Large, red opaque	24.2
Cuarzo Rojo	Large, red brilliant	6.9
Cuarzo Amarilli	Large, yellow opaque	6.0
Total		100.0
Climbing Beans		
Sangre Toro	Large, red brilliant	45.8
Revoltura	Mixture of types	20.8
Cuarzo de Vara	Large, red brilliant	10.4
Liberal	Small, red brilliant	6.2
Care Vaca	Medium, red-white opaque	4.2
Bolon Rojo	Medium, red brilliant	2.1
Mortino	Large, purple opaque	2.1
Algarrobo	Medium, red-yellow opaque	2.1
Blanquillo	Medium, white opaque	2.1
Conejo	Small, brown opaque	2.1
Novillona	Medium, red-white opaque	2.1
Total		100.0

inferior grain types were utilized in subsistence production and thus might find acceptance still if women were included in the evaluation process.

The group decided to table the question of which varieties to plant until the following morning's meeting. Their tasks at that meeting would be to make a decision on varieties and to design on-farm trials which experimented with all three elements—fertilizer responses, farmer management practices, and selected bean varieties. The sociologist reminded them that in thinking about trial designs, they should consider their objective of implementing farmer participation in experimentation.

STUDY QUESTIONS

1. What are the objectives of the research?
2. What is known about men's and women's roles with respect to bean production in Pescador?
3. What are the different kinds of beans grown in Pescador? What are the cultivation practices associated with them and what are their uses?

4. What should be the main components of an experimental program in February in terms of *(a)* varieties, *(b)* fertilizer use, and *(c)* farmer management? How can farmer participation be maximized? What further research would be useful at this phase?

   (alternate) Develop an on-farm experimental program for beans. Consider the trial objectives, the group of farmers to which it is directed, treatments and levels for each trial, selection criteria for cooperators, and data to be collected for evaluation purposes. What additional research should be done?

NOTE

1. The Centro Internacional de Agricultura Tropical (CIAT) is a nonprofit agricultural research organization headquartered in Cali, Colombia, with regional cooperation staff posted in Central and South America, Brazil, Peru, Asia, and Eastern Africa. CIAT is one of the thirteen International Agricultural Research Centers (IARCs) under the auspices of the Consultative Group on International Agricultural Research (CGIAR) which was formed in 1971 by donor agencies in order to provide long-term support for agricultural research in the developing world. All the IARCs have specific mandates for commodities, regions, or other areas important to agricultural research. CIAT's work is concentrated in four commodity programs: rice, tropical pastures, cassava, and beans. The Bean Program's mandate is to stabilize dry bean production at high levels, especially in regions where the crop plays an important role in human diets.

   Because beans are grown under a wide range of environmental and socioeconomic conditions, neither a single variety nor several varieties can meet farmers' needs over a wide area. For this reason, the Bean Program has focused its research on small farm production systems, with emphasis on developing technology requiring as few purchased inputs as possible and on the incorporation of desirable characteristics into improved bean genotypes. To do this, the Bean Program is using farming systems research and extension perspectives and methodologies in order to design effective on-farm research methods for developing bean technology and for adapting that technology to specific areas. The CIAT Bean Program's on-farm research activities fall into the category of farming systems research "with a pre-determined focus."

   In Colombia, CIAT's on-farm bean research is conducted in collaboration with several other entities, both international and national. The Bean Program cooperates with the International Fertilizer Development Center (IFDC) in a phosphorus project that involves on-farm research in various Colombian locations. Intercropping and economics studies have been done with FEDECAFE (Federacion Nacional de Cafeteros), the Colombian national coffee growers' federation. This is part of a larger government effort to help farmers diversify their production from coffee. Though there were no formal linkages, the development of improved bean varieties would be useful to the government's seed multiplication and extension programs.

Colombia: Part 2 Experimentation, Ongoing Diagnostic Research, and Evaluation

EXPERIMENTATION

Planning

The final research design for on-farm experimentation included three levels of the proposed fertilizer mixture and two levels of pest and disease management. These were designed to simulate the two farmer strategies found in the diagnostic research:

1. Typical farmer management, which aims for minimum input control of pest and disease, is interested in disease-resistant varieties and tends to apply high levels of fertilizer for beans;

2. Innovative farmer management, which aims for optimum pest and disease control including more labor, wants increased productivity from varieties, but wants to reduce overall cash expenditures mainly via reduced fertilizer costs.

With regard to varieties, the team accepted the argument that apparently inferior beans might be utilized in subsistence agriculture. Therefore, it was decided not to discard varieties which had been ranked low by the farmers as a group, but to include a larger mix of varieties in the agronomic trials than originally planned.

The final experimental design for exploratory trials which the team drew up from this discussion to test fertilizer-varietal interactions with two levels of management proposed to address the following objectives:

1. to identify fertilizer-responsive and disease-resistant varieties suitable for typical farmer (or minimum input) management of pest and disease;

2. to identify varieties which would respond to innovative farmer (or high input) management of pests and disease at lower fertilizer rates and costs compared with a farmer fertilizer check treatment;

3. to select a reduced number of varieties for further testing in regional trials to be carried out subsequently.

The social scientists questioned the compatibility of the experimental design, given its complexity and large number of treatments, with the objective of the project to implement farmer participation in the assessment of new technology. Moreover, the design required a large-sized plot relative to the size of most farmers' bean plots. The team accordingly established this design as an exploratory trial, with only two farmers, and implemented farmer participation in a larger number of farmer-managed trials. The latter would superimpose the new varieties onto a range of farmer management and fertilization practices in order to enable farmers to become familiar with and evaluate the varietal materials, and to enable them to participate in the selection of varieties which would enter into subsequent fertilizer trials.

Farmers who planned to plant beans in February were contacted. The social scientist and the agronomist selected thirteen farmers from among them to take part in the farmer-managed trials. These farmers were selected to represent a range of socioeconomic resources, identified in terms of indicators such as farm size, ownership of livestock, nonfarm employment, and whether their management style for the bean crop would be typical or innovative.

Exploratory Trial

The exploratory trial (see Table 5-11) was established in fields belonging to two farmers, with an agreement that each farmer would spray his crop once to represent traditional or minimum-input management of pest and disease control on two replications in the trial at the time judged appropriate. Innovative or high-input management would include additional crop spraying of the remaining two replications, implemented at the judgment of the agronomist responsible for overall management of the trial and based on his observation of how "innovative" key informants in the vicinity were treating their bean crop.

Farmer-Managed Varietal Trials

The farmer-managed varietal trials were designed to be as simple as possible so that the eleven cooperating farmers could plant and could evaluate readily several varieties. The layout for the trial plots was staked by the agronomist's assistant in the fields designated by each farmer for planting that season's bean crop. Each farmer was provided with separately labeled packets of seed for each variety. Farmers planted one packet of seed or one variety in each parcel staked out in the field, starting at the top end of a parcel and planting as far as the seed lasted. The last row of the variety

Table 5-11

Experimental Design for Exploratory On-farm Trial

Treatment Number[a]	Management[b]	Fertilizer Mixture	Product Rate RF[c]	CM	S
		kg/ha	(kg/ha)		
1 – 8	TF	1,153.8	195	945	15.6
9 – 16	TF	2,307.7	390	1,890	31.2
17 – 24	TF	3,461.5	585	2,835	46.8
25 – 32	IF	1,153.8	195	945	15.6
33 – 40	IF	2,307.7	390	1,890	31.2
41 – 48	IF	3,461.5	585	2,835	46.8
49 Farmer check	TF	2,307.7	0	2,307.7	0.0
50 Farmer check	IF	2,307.7	0	2,307.7	0.0

[a]Each fertilizer treatment repeated with 8 bush bean lines = AFR-205, A-486, A-36, A-66, PVAD-1261, BAT-1297, ANTIOQUIA-8L40, CALIMA (local check).
[b]TF = traditional farmer management; IF = innovative farmer management.
[c]RF = rock phosphate; CM = chicken manure; S = sulfur.

was marked with another stake. The remainder of the field was planted on the same day using the farmer's preferred local variety. The farmer was to carry out the usual management operations for the whole bean plot.

Data on labor and other inputs, including fertilizers and chemicals for fumigation applied by each farmer, were recorded. Each farmer had a simple record-keeping sheet for entering labor inputs and purchased inputs as they applied to the whole bean field, including the trial plot.

PARTICIPANT OBSERVATION

While the agronomic trials were being planted, the social scientists conducted further diagnostic research to discover what role women's preferences might play in technology adoption and how these preferences could be given scope in the testing and evaluation of the technology.

The sociologist decided that the informal survey approach to diagnostic research which had utilized random meetings with farmers in their fields had excluded the researchers from contact with women, whose activities were centered around the farmhouse and the domestic sphere. Meeting farmers in their fields may have biased some of the earlier findings. However, efforts to interview women through visits to their homes were consistently frustrated by the perception of the women themselves that the men of the household were the relevant informants in an interview situation. Women were "too busy" to sit and talk, a situation in which they were evidently ill at ease, particularly in the presence of the men of the household.

To overcome these problems, a different approach was devised. The sociologist selected ten families participating in the farmer-managed trials with which to conduct case studies. Participant observation methodology was utilized to spend part of a day each week helping out in the kitchen of each household alongside the women for a period of six weeks. The sociologist observed women's activities while taking part in their tasks and in their conversations, and shared in the family meals and in other activities (such as husking maize, packing tomatoes in cases, or sorting coffee beans) in which the whole family took part. As the sociologist became integrated into these domestic activities, the problem of access to women as informants was solved.

This methodology very rapidly showed, in the course of a few weeks, that women's participation in production activities had been underestimated in the initial diagnostic interviews with male key informants. Women were involved in a broad range of activities outside the domestic sphere.

Women spent a major part of their time in the kitchen preparing meals that they carried to the fields. Most families hired some laborers who had to be fed three times a day. The use of hired labor is an integral feature of the farming system, not only for the main cash crop, coffee, but also for other cash crops such as cassava, sugar cane, bush beans, and tomatoes. Cauca Department, where Pescador is located, is one of the lowest wage areas of Colombia, and labor migrates seasonally to higher wage areas. As a result, it is almost impossible to obtain labor at local wage rates outside the pool of workers constituted by the extended family and neighbors.

Family labor, such as when sons work for their fathers, is customarily paid the going wage. Hired laborers are typically the young adult men from farm families in the community, and providing these youngsters with employment to keep them living at home and to discourage them from migrating elsewhere is part of the motivation for using hired labor among local farmers.

Local wages were Col $200 per day with meals, or Col $400 per day without meals. The quality of meals could be a factor in the ability of farmers to attract laborers, and farmers without women in their family to prepare meals either could not obtain labor or had to hire someone to prepare meals. Farmers explained that they preferred to hire laborers on a wage basis that included meals, not only because it involved less cash outlay, but also, most importantly, because laborers would turn up for work earlier in the day and stay longer if meals were provided.

The social scientist discovered that the preparation of meals drew on a wide variety of foodstuffs available from the farm. Some of these were brought to the farmhouse from outlying plots by the men and were stored in the farm storeroom. Close by the farmhouse was the *huerta* (homestead plot), usually an agroforestry garden of foodstuffs in daily demand:

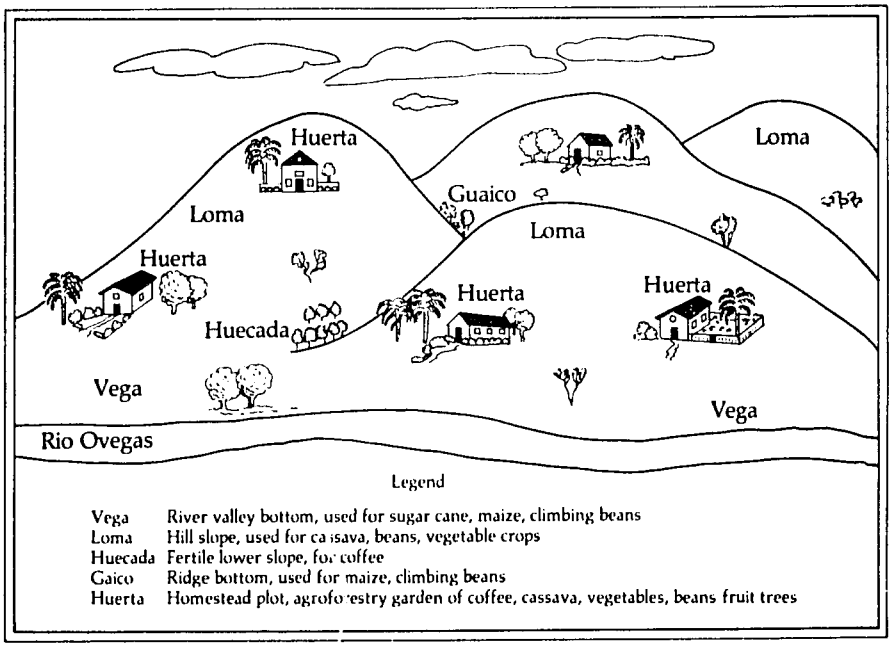
coffee, plantains, fruit trees, cassava, medicinal herbs, cucurbits, and minor root crops. These plots were cared for by women. Sometimes the *huerta* also included a small fenced area where maize, beans, and vegetables were cultivated (see Figure 5-3). Crops grown in the homestead plot supplied many of the ingredients for the traditional *sancocho* (stew) that is basic to the local cuisine. Although the contents of the daily *sancocho* prepared by women for family and laborers were varied, some ingredients were considered an indispensible component of the meals and they represented part of the hired workers' remuneration.

One of the vital ingredients in laborers' meals was beans. Several farm women explained that beans could be substituted for meat to accompany the rice and the soup in the customary *sancocho* prepared for field laborers' meals. When the farm housewife had a stock of beans produced on the farm, savings could be made on meat which otherwise had to be purchased.

Women also influenced production decisions through their part in managing consumption. The adult men in farm families customarily contributed cash as well as a certain amount of the farm product in kind toward the household expenses. These cash and kind resources were managed by the women. The amount of the contribution might be decided by the men, but women significantly influenced what foodstuffs should be

Figure 5-3

Types of Plots in Pescador



provided from the farm, and this appeared to affect decisions about what should be planted.

Decision making in the household about resource allocation did not take place in clearly demarcated gender-related spheres of influence. Women's influence on production decisions might be indirect: for example, by insisting certain resources of cash be devoted to school expenses or medical care for children, women indirectly influenced cash availability for purchasing agricultural inputs. In such cases, women's influence on farm management was the result of a negotiated or bargaining process of decision making that sometimes included several adults in the family network, such as the husband and wife, their parents, and other relatives or neighbors whose resources might be involved in production decisions.

Participant observation showed that, although women seldom directly managed the inputs and outputs of field crop production, they actively expressed an interest in production practices and discussed among themselves and with men which crops and varieties were high yielding or profitable. Some of the younger farm women explained their concern with these issues in terms of their perception that providing food and income from a farm was a partnership between husband and wife, who shared the responsibility of providing for their family. Young women could migrate to the city, and in many cases had done so before marriage to work as domestic servants. Women who could earn an income did not have to stay on the farm. These women were interested in making an economic contribution which the men had to recognize and respect. They often took out credit and hired labor to work on plots of land which were legally theirs through inheritance or which belonged to their parents. Newly married daughters living in the extended family household were loaned or given plots of land to cultivate by their parents to enable them to accumulate capital toward setting up their own households. These young women and their husbands were often the most actively interested in trying out new crops, such as bush beans or tomatoes, and in trying out new techniques which would enable them to maximize income and savings toward setting up their own independent households.

EVALUATION

Exploratory Trial

Harvest time arrived and the results of the on-farm trials were evaluated by the research team. Data from the exploratory trial were processed, and an analysis of variance was made to evaluate fertilizer and variety effects under two management strategies (see Table 5-12).

Several response function models (quadratic, semilog, and linear) were tested for the range of fertilizer rates used. The response function

Table 5-12

Analysis of Variance to Evaluate Fertilizer and Variety under Two Management Strategies

Source of Variation	Degrees of Freedom	Dependent Variable: Bean Yield	
		Traditional Management	Innovative Management
		% of sums of squares	
Replications	1	0.8 NS	3.90 NS
Fertilizer	2	44.83[c]	27.78[c]
Variety	8	12.20[a]	41.60[c]
Variety x fertilizer	14	24.68[a]	11.82 NS
Error	24	18.21	14.90
Total	49	100.00	100.00

Source: J. A. Ashby and J. Henao, "Farmers' experimental strategies as a diagnostic tool for design of on-farm trials" (1986), in preparation.
[a]Significant value at 0.05 probability level
[b]Significant value at 0.01 probability level
[c]Significant value at 0.001 probability level

analysis found that under traditional or minimum-input management only two bean varieties showed significant response to fertilizer (BAT-1267 and PVAD-1261). Under innovative or high-input management, all the bean varieties with the exception of one had significant response to fertilizer, although a much lower proportion of variation in yield could be explained by the model.

In summary, the analysis of the exploratory trial indicated that the four best bean varieties for inclusion in further trials would be BAT-1297, A-36, A-486, and PVAD-1261. However, BAT-1297 was the lower quality, small grain type of bean. The question remained, would farmers accept this variety if recommended?

Varietal Trials

Approximately sixty days after planting, the first stage of the farmer evaluation of the farmer-managed trials took place. The agronomist and sociologist accompanied each farmer to his bean trial and asked him to evaluate the appearance of the different treatments. Farmers' comments on plant architecture, disease susceptibility, or other characteristics of the bean plants were noted (see Table 5-13).

After harvesting the varietal trials, the researchers took samples of each variety to local middlemen and asked several farmers to do the same. In this way, they estimated a price for each variety and found that, as expected, the small grain type BAT-1297 received a significant price discount. A simple partial cost-benefit analysis was conducted with each farmer, uti-

Table 5-13

Farmers' Visual Evaluations of Farm Trials *(N=11)*

	Bean Variety Characteristics							
Variety	High Yield	Low Yield	Early	Late	Infected	Disease Resistant	Upright Plant	Sprawling Plant
Most preferred								
A-486	100	—	22	—	11	22	22	—
PVAD-1261	100	—	—	11	22	11	44	—
BAT-1297	77	—	—	11	22	—	—	44
A-36	55	—	—	11	11	11	—	11
Least preferred								
Calima	55	—	—	—	11	44	—	—
ANTIOQUIA	—	11	—	55	11	33	—	11
ANCASH-66	—	11	—	55	33	11	—	44
AFR-205	—	11	—	—	11	44	—	11

lizing the grain yield from each variety in his trial, the cost of fertilizer he had applied, and the estimated prices. BAT-1297 was consistently the most profitable variety when grown in farmers' fields. Farmers then selected three or four preferred varieties and ranked them in order of preference. The results showed that the two varieties selected in first order of preference by farmers were consistent with the earlier predictions of the breeder: A-36 and A-486 were the top-ranking varieties (see Figure 5-4).

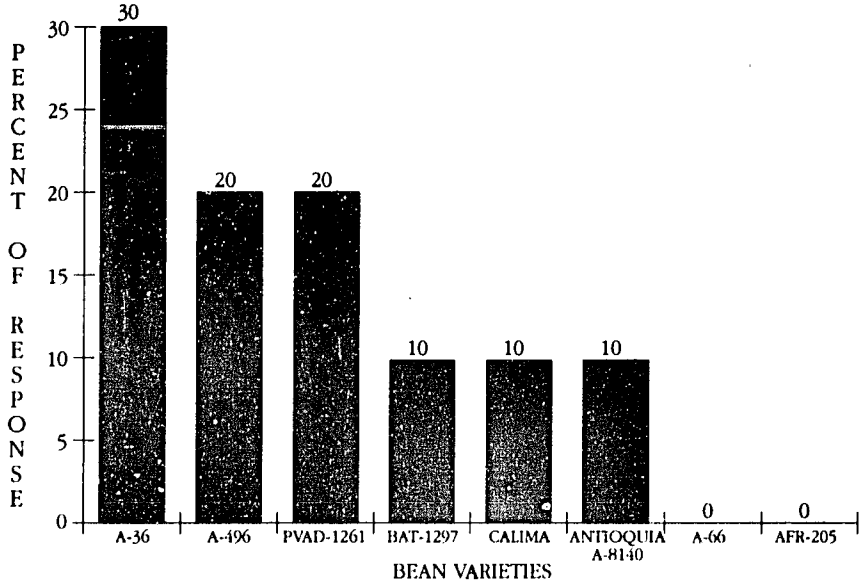
Consumption Characteristics

The social scientists felt that the findings of the diagnostic research, which showed the role of beans in the management of household food supplies by farm women, suggested that consumption aspects of the varieties required evaluation. The sociologist conducted a series of interviews with women in the families participating in the trials to find out what criteria women utilized to define an acceptable bean variety. Women told her that they looked for several features when cooking beans: flavor, color of the broth, softness of skins, and quickness in cooking time. Most importantly, they said that the bean should swell and "yield in the cooking pot" so that a small quantity of beans would provide a substantial number of servings.

The sociologist identified two groups of women who took responsibility for organizing social get-togethers in the community for religious festivals and other communal events and asked them to collaborate in a cooking test of the eight bean varieties, including the locally preferred variety. Each variety was assigned a letter from A to H; the women cooked

Figure 5-4

Men's Responses to "Which Variety Would You Rank First?"



each one in quantity in a separate cooking pot, using a local recipe, over a wood fire. This cooking test was carried out on two separate occasions. The women gave each variety a score on the quickness of cooking and yield in the cooking pot. They invited their families along, and everyone tasted the beans one by one in small amounts. The women assessed each variety on flavor, color, and softness, and they recorded their three most-preferred varieties and ranked them in order (see Figure 5-5).

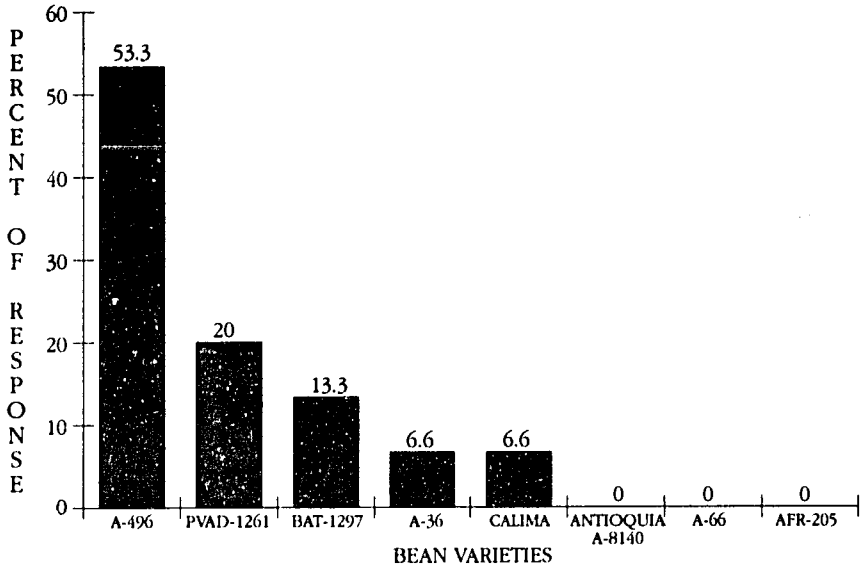
Given the results of the agronomic evaluation from the exploratory trial and these two sets of preferences, the researchers confronted the question of which varieties would ultimately find widest acceptance in the farming community. Which varieties should be excluded from further testing? What combination of variety and fertilizer technology would be feasible? By now the second planting season had arrived, and it was time to reestablish the exploratory trials and farmer-managed trials to evaluate the performance of the technology in different seasonal conditions, as planned.

Follow-up Dissemination Study

In an effort to clarify the selection of a preferred variety for inclusion in future trials, the social scientists decided to carry out a follow-up study to see which varieties were being disseminated as seed or replanted by the families who had participated in the varietal trials. In September, at the

Figure 5-5

Women's Responses to "Which Variety Would You Rank First?"



beginning of the subsequent planting season, they visited families to ask both men and women which varieties they had replanted, given away, or sold to neighboring farmers. The results showed that varieties preferred for their consumption characteristics in the evaluations conducted with women were being most widely replanted after the conclusion of the on-farm trials (see Table 5-14).

Notably the variety BAT-1297, which the breeder had anticipated would find little acceptance, was reported by farmers as popularly in demand among neighbors. The researchers met other farmers in the community who had heard that BAT-1297 was high yielding and very tasty, and, even if not readily sold on the market, that it was very useful for household consumption purposes. As one farmer put it: "I want to plant A-36, but my wife insists that she will plant BAT-1297 in her garden because she wants these beans for housekeeping purposes." For these reasons, they were anxious to obtain the seed and often requested it.

Reanalysis of Varietal Preference

The social scientists decided to reanalyze varietal preferences expressed by men, based on the trial results in the households that had been selected for case study analysis. They found that farmers who ranked large-grain varieties highly in the trial evaluations formed a group distinct from

Table 5-14

Percent of Times Each Variety Replanted and/or Seed Given to Other Farmers by Farm Trial Participants

Bean Variety	Percent	Bean Variety	Percent
A-486	30.2	ANTIOQUIA	9.3
BAT-1297	23.2	ANCASH 66	6.9
A-36	13.9	AFR-205	6.9
PVAD-1261	9.3		

those who ranked small grain varieties highly. By examining differences in age, family size, and family structure, the farmers who preferred large-grain varieties (A-486, AFR-205) could be characterized as either unmarried or recently married, and living in extended families. They were members of large households, including their parents or in-laws, where several adults were engaged in farming in a mixture of cooperative arrangements for sharing land, as well as independently owned and managed plots. These families included entrepreneurial young men and women, or couples, who were spearheading the introduction of tomatoes and horticultural crops into the farming system.

Many belonged to a self-proclaimed group of tomato growers which had formed in the community to share experiences with tomato production technology, and which was attempting to set up a cooperative to obtain technical assistance and to market tomatoes. These young people typically had access to capital, often from nonfarm employment, but had limited access to land. They were often motivated toward maximizing cash income with the objective of getting married and/or setting up independent households. Their agricultural activities were heavily market oriented in new crops, such as beans and tomatoes, which were perceived as risky in the community. Their investment in risky, market-oriented enterprises appeared to be viable because they typically contributed cash to the extended household, and they were not obliged to provide traditional subsistence crops for household consumption nor were they obliged even to contribute a regular input to the weekly housekeeping budget. The extended family provided for these needs, and so functioned as a safety net for young people to experiment with new technology. Both young men and women in this position in extended families were interested in the new large-grain bean varieties because of their profitability, and because they were aggressively seeking new market outlets for their production outside the local community.

Farmers who had an expressed interest in small grain varieties, in particular BAT-1297, were in a different position in their domestic life cycle and in their family structure. This group included young farmers

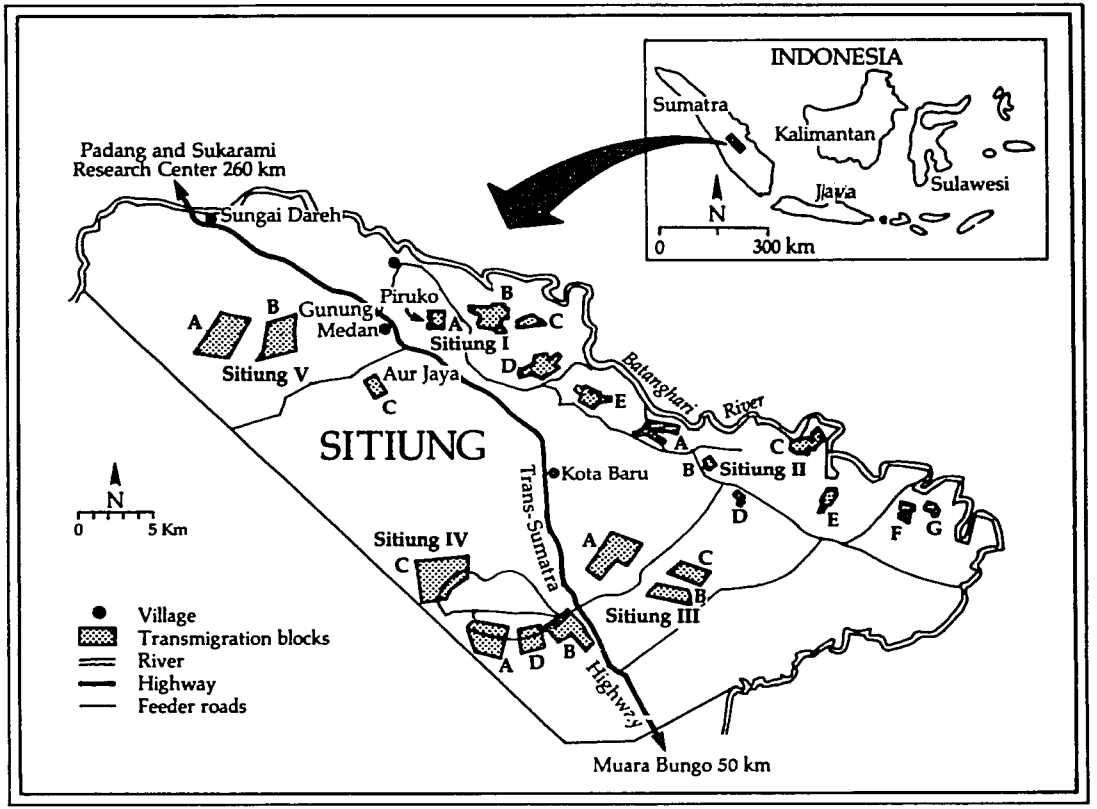
who had set up their separate households and were heads of household of a nuclear family with infants or school-age children. Also included in this group were farmers who were heads of household of extended families. Their preferences for bean varieties were related to both market and household consumption objectives. The men were interested in a bean type which had an established niche in the market, and which they could rely upon selling. However, in such families there was an explicit recognition of different preferences of women toward the new varieties.

The research team was informed that a meeting was to be held the following day to discuss what had been learned about household preferences concerning beans. The team members were asked to consider what further experimentation should be done. They were also asked what recommendations could be made to small farmers and to the government of Colombia. In addition, considering what they had learned from the first season's research activities, what recommendations could they make to other agricultural research institutions?

STUDY QUESTIONS

1. What was learned about incentive structures in bean production? Household resource control? Household preferences for bean varieties?
2. What research activities were actually undertaken during the project? Where were they located? What are the strengths and weaknesses of each activity?
3. What should the research team recommend to small farmers? To the government of Colombia? To similar research institutions?

Figure 6-1
Map of the Sitiung Transmigration Area, West Sumatra, Indonesia



Chapter 6

Indonesia

Farm-based Research in the Tropsoils Project, Sitiung

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Part 2 Research in the Second and Third Year (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

Indonesia: Part 1
Diagnosis and First-Year Experimentation

BACKGROUND

The Tropsoils Project

It was November, the rains were underway, and the second full agricultural year for the Tropsoils team had begun.[2] Farmers from Sitiung I who had *sawah* fields for wet rice production were planting the first of their two crops; farmers in Sitiung V were planting their only rice crop on their *ladang* (dry upland fields). Fifteen months had passed since the full Tropsoils team had begun work at the Sitiung transmigration site in West Sumatra. Joan, an anthropologist and the team's farming systems specialist, was pleased with the first year's efforts. She and her soil scientist colleagues, Bill and Mulyadi, had begun to explore with migrant and indigenous farmers the possibilities for improving soil management; and progress had been made in improving the team's understanding of the relationship between soil management and people's lives.

It was the intention of the Indonesian government ultimately to transfer soil management and farming systems principles discovered in Sitiung to other transmigration sites. Thus, the principal goal of the Tropsoils Project was:

> to uncover principles which will enable resource-poor farmers to adopt soil management practices that will increase family income and farm productivity and at the same time preserve land quality. The research strategy is designed to insure that social, cultural, economic, and environmental factors that enhance adoption of a soil management innovation are made an integral part of the research plan. To achieve its goal, the project conducts a major portion of the soil management research with farmers and in farmer fields (McCants 1985, 22).

The previous August, the Tropsoils team had to move quickly to determine whether and what on-farm trials to initiate before the September/October planting season. In making their decisions, they had information on soils gathered by the Indonesian members of the team (see Appendix 6-A), background information on the Sitiung transmigration project, and a four-day *sondeo*[3] of the five Sitiung sites by the team.

	INDONESIA
Area	13,000 islands; land area 741,101 mi^2 of which 7% is in Java and Madura.
Population	156 million. Two-thirds live on Java and Madura; 74% in rural areas.
Income	GNP/capita: U.S. $560 (1983). Sources: agriculture 26%.
Climate	Humid tropics.
Currency	Rupiah (Rp). Rp 1,126 = U.S. $1 (1985–86).
	SITIUNG, WEST SUMATRA
Area	60,000 ha.
Population	ca. 24,000 families (1/2 are transmigrants).
Income	Sources: subsistence agriculture, off-farm labor.
Topography	Dissected peneplain; flat area near most homesteads, sloping upland areas.
Elevation	70–80 m above sea level.
Rainfall	Average rainfall 2,500 mm. Ranges from 66 mm (August) to 450 mm (April). Extremely variable and characterized by frequent short droughts.
Temperature	Mean 26° C. Ranges from 31.6° C (May) to 20.9° C (August). Relative humidity ranges from 62.2 to 81.3. Sunshine averages 4–6 hr/day.
Soils	Highly leached, consistently acid, highly weathered clay; infertile (low in bases, phosphorus); high in aluminum.
Vegetation	Tropical rainforest.

The Transmigration Site

The Sitiung transmigration area includes twenty-four blocks (villages of 300–500 transmigrant families) interspersed with fairly small indigenous communities. Sitiung I (five blocks) was established in 1976 by transmigrants from the area of Wonogiri in Central Java. The entire population—rich and poor—had been moved *in toto*, prompted by the construction of a large dam which flooded their original lands.

Sitiung V, in contrast, was settled in 1983, populated by volunteers from different areas: Javanese from East Java, Sundanese from West Java, and Minangkabau. The transmigrants had come from densely populated Java, where land was of utmost value and scarcity. The soil was of excellent quality, and the system that had evolved included intensive management of very small permanent plots. The Minangkabau are the indigenous ethnic group, originally from nearby communities. Recent government policy required that each transmigrant settlement include 10 percent indigenous peoples.

Transmigrant families were provided with a modest house, a hectare of cleared land some twenty minutes' walk from home, and a quarter hectare around the house. One hectare is *ladang* and the home garden plot is of comparable quality. Only Sitiung I residents had *sawah* fields in addition to *ladang* and home garden plots.[4] Under transmigration project guidelines, only food (not tree) crops could be planted on the upland fields. During the first year, the government provided a subsidy of food (rice, oil, and dried fish), cooking and agricultural implements, seeds, fertilizer, and insecticide.

Transmigrant land is legally titled to heads of households. In one block of 569 families, the records showed that 42 families or 7 percent of these families were headed by females.

The *Sondeo*

A *sondeo* undertaken by Joan, Bill, Mulyadi, and six agricultural technicians had confirmed the poor soil conditions. Most of the Sitiung sites, originally tropical forest, had been cleared by bulldozers. The bad experience with bulldozers in Sitiung I resulted in a manual clearing policy in Sitiung V. In Sitiung V contractors cut the forest in October, at the beginning of the rainy season, and then left the felled logs for the transmigrants to clear themselves, a back-wrenching operation. It was impossible to get a good burn of such rotted trees and leaves, and transmigrants were left with very imperfectly cleared fields until nature, and several seasons of cultivation, completed the task.

Differences between Sitiung I and V emerged sharply in the *sondeo*. Sitiung I was long established, ethnically homogeneous, and marked by a range of income levels. Sitiung V was new, ethnically mixed, and uniformly very poor. There seemed to be more livestock—cattle, chickens, goats—in Sitiung I than in Sitiung V. Women, children, and men carrying heavy loads of grass were common sights in Sitiung I. Most homes had established home gardens and there were crops in their fields. The houses had been modified—rooms or lean-tos had been added.

Fields littered with felled logs were the dominant images from Sitiung V. Identical white, square wooden structures clustered in the center; forest surrounded the fields. The home gardens were nearly bare, with dying plants everywhere.

The people were coping with the shock of moving from densely populated, intensively cultivated Java to the "empty jungles" of Sumatra. They expressed fear of the forest and anxiety about their subsistence because nothing seemed to grow, and dismay that many of the government's promises had not yet materialized. Yet the hope they also felt was obvious: pleasure at owning such a large plot of land and an expectation of a better future for themselves and their children.

Team members had tried, in the *sondeo*, to shed light on division of labor and on resource management within the households. Based on her previous work elsewhere in Indonesia, Joan thought women were probably involved in agricultural production. But it remained unclear to what extent the transmigrant women were involved in agricultural work and decision making. The degree to which ethnicity was an important variable was also unsettled. The *sondeo* did provide them with preliminary information on the different kinds of fields and the prices of inputs and outputs. The team prepared an initial list of problems and opportunities. (See Appendix 6-B.)

The team decided to plunge into collaborative work with farmers immediately. They wanted close and continuous interaction with the farmers to help them develop an appropriate research agenda. Working alongside farmers in farmer-managed exploratory trials appeared to be an ideal mechanism. Joan also knew the researchers would need a better handle on people's allocation of their time. Who was doing what and when? She started a time allocation study in Sitiung I and V to gain quantitative data on the two contrasting locations. The agronomist planned a researcher-managed trial on pasture grasses and legumes. To complement the work on soils, a survey on income and food practices was undertaken.

COOPERATOR FARMER EXPLORATORY FIELD TRIALS

Research Site Selection

In September, Bill, Joan, and Mulyadi decided to work in Aur Jaya block in Sitiung V—a community of 1,466 containing 300 families. The population was two-fifths Sundanese, two-fifths Javanese, and one-fifth Minang. Each of these groups had its own native tongue. Most men in each community spoke Indonesian. Interaction between the team and the farmers and among farmers of different ethnic groups occurred in Indonesian unless the team member and the farmer happened to be of the same ethnic group. Aur Jaya represented a good opportunity to work collaboratively with farmers in a situation where both researchers and farmers were new to an environment; to document changes in soil and in farmers' soil management practices as a new settlement was developed; and to work where the need was greatest.

Working with Farmer Collaborators: The Process

The researchers recognized the equity-related pitfalls of choosing cooperator farmers via existing community leaders (all male), but the

shortage of time forced them to do so. Four community leaders each chose five cooperating farmers.

Bill and Joan called meetings with each of the four small groups. Joan personally invited Sitiung women to the meetings. Bill and Joan both asked husbands to invite their wives, but women did not attend the meetings. They seemed to view the invitations somewhat humorously, mentioning childcare responsibilities, shyness, or lack of knowledge of Indonesian as excuses.

In these small group meetings, Joan, Mulyadi, and Bill talked with farmers about their work in Sitiung. They explained that their goals were to develop agricultural technology that was usable by and of interest to farming households. They stated their desire to learn from farmers, to incorporate farmer knowledge and experience into project research efforts, and to develop technologies that farmers could afford. Based on these discussions, each of the twenty farmers decided to work with the project. A meeting of all farmers was then called. Again, wives were invited but did not attend.

Cropping patterns and plans. Bill, Mulyadi, and Joan prepared a possible experimental plan, based on the cropping pattern suggested by the Indonesian Food Crops Institute in Sukarami. The plan included a cropping pattern and four soil amendment treatments. Four trial plots, each ten meters by twenty meters, were to be located on the *ladang* fields. When the team presented the plan at the meeting, they stressed that it was only an idea.

The team proposed that farmers first plant rice to be intercropped later with cassava. This would be followed by a second-cycle crop. The second-cycle crop would be an edible legume such as peanuts, mung beans, or soybeans. The legume was to be planted between the growing cassava rows. After harvesting the legume, a third-cycle crop was to be planted. This third-cycle crop would be a leguminous ground cover such as calapagonium, spread over half of each plot. The other half would be planted to vegetables. Planting vegetables would be a first effort to ensure that the project was attending to nutritional concerns.

This plan was thoroughly discussed at the meeting. To the researchers' delight, farmers freely made suggestions. Farmers chose to follow rice with mung beans. The vegetables they wanted to plant included tomatoes, chilies, eggplant, and long green beans. One Javanese farmer suggested planting mucuna beans rather than calapagonium as the cover crop, since the East Javanese eat mucuna beans and the plant has the same soil-enhancing function as calapagonium. There was considerable hilarity at the meeting about the prospect of the Sundanese and Minang who don't like mucuna beans selling theirs to the Javanese.

Soil fertility treatments. Four soil fertility treatments were suggested by Bill:

1. No fertilizer or lime ("control")

2. Government-supplied fertilizer applied at government rates: 100 kilograms each, urea and triple super phosphate (TSP) per hectare ("government")

3. 800 kilograms rock phosphate per hectare and government-supplied fertilizer as above ("rock phosphate") (Rock phosphate was provided by the government transmigration program. In some areas it was applied to all cleared lands prior to the settlers' arrival.)

4. 2.5 tons lime per hectare and 100 kilograms urea per hectare and 200 kilograms TSP per hectare ("lime")

The team emphasized that the inputs being provided as well as farmer participation in the planning effort committed farmers to doing what was jointly decided. Farmers agreed.

The farmers' new fields were littered with logs. To help clear the land, the researchers bought a chainsaw and hired some workers to saw logs into manageable sizes. Then several team members helped farmers roll logs off the fields—an important means for establishing rapport.

Field trial work: First crop cycle. Mulyadi had noted a few stands of good rice in Aur Jaya on an earlier visit. He later went to Garut, West Java, (the source) and brought back enough seed—half a red variety, half a white—for all twenty farmers. Since farmers unanimously preferred the red variety, researchers split the original plots in two—one-half for red rice, one-half for white.

The actual work began. The team worked with the twenty farmers daily. They helped lay out plots, delivered lime and fertilizers, and helped plant rice. This participatory process enabled them to observe both men and women working in the fields.

The process of negotiation and compromise required changes in the plans. Several farmers informally suggested to Bill that corn be added to the cropping pattern. A design incorporating corn rows between the rows of rice was drawn up. A meeting was called, an agreement was reached, and the new planting pattern was explained to all the cooperating male farmers.

A Sundanese farmer made the first in a string of complaints that it was too hard to hoe the lime and phosphate plots (treatments 3 and 4). Field inspection showed the farmers' plots to be a tangled mass of roots just below the surface, nearly impenetrable by a hoe. Several farmers' government-provided hoes had broken during the hoeing process. Seeing the genuine difficulty, Bill agreed to modify the experimental design. Light hoeing of the lime and phosphate plots was specified. Joan, Bill,

and Adi (a technician from the Centre for Soil Research) realized that they would never have understood the legitimacy of the farmers' complaint had they not been working daily with the farmers in their fields.

A second alteration also related to hoeing: a Minang farmer did not want to hoe the lime and phosphate plots at all; the Javanese and Sundanese were avid hoers. Not to hoe was considered by them to be the utmost in laziness. Fields in Java are bare ("clean") between cultivated crops. The Minang, in contrast, never hoed unirrigated rice fields. Rather, after a slash and burn, they planted with a dibble stick. In their view, hoeing upland rice was simply not worth the effort.

When it became clear that the Minang farmer was simply not going to hoe, Bill and Mulyadi opted to alter the experimental design. With three farmers not hoeing lime and rock phosphate plots at all, research comparisons could be made between those plots that were lightly hoed and those that were not hoed at all. The yields of rice from different experimental treatments are illustrated in Table 6-1.

The corn crop had fizzled. Women, who had no direct instruction in how to plant the trial and who had not attended the farmer meetings, had planted most of the corn incorrectly. Additionally, the decision to plant corn was made very late. The rice overwhelmed the emerging corn. Mice and rats wreaked additional havoc. Only two farmers got any significant corn yield.

Second crop cycle. Following the suggestions of farmers who had been experimenting with chilies and peanuts in their home gardens, the researchers and farmers agreed to change from mung beans to peanuts and/or chilies for the second crop. Peanuts would follow the white rice,

Table 6-1

Rice Yields As Affected by Fertilizer and Tillage

Treatments	No-Till		Till		Average
	kg/ha				
1. None: Control	360	(12)[a]	570	(7)	440
2. Government treatment (100 kg/ha each, urea & TSP)	420	(9)	670	(10)	550
3. Rock phosphate (800 kg/ha + treatment 2)	560	(3)	680	(16)	600
4. Lime (2.5 t/ha) + Urea (100 kg/ha) + TSP (200 kg/ha)	730	(3)	680	(16)	690

Source: Wade, Agus, and Colfer (1985).
Note: The least significant difference (LSD) at 0.5 level is 120.
[a]Numbers in ( ) are number of farmers using that practice.

and chilies, the red rice. All farmers hoed land after the rice harvest and before planting peanuts. Joan, Bill, and Mulyadi were comparing notes one day on the trial, and discovered that, without exception, Sundanese farmers had requested chilies and Javanese farmers had requested peanuts.

Planting chilies in *ladangs* was an unqualified disaster. The potential for intensive management and the higher fertility of Aur Jaya's home gardens (because government fertilizer allotments were often used exclusively on the home garden) surely contributed to this differential success: chilies have a high nutrient demand. The modest fertility program on the trial plots was not adequate. Additionally, efforts at disease control proved ineffective.

The peanuts gave reasonable yields. They were more hardy than chilies and less in need of fertile soil. The fertility treatments showed significant differences, as illustrated in Table 6-2.

Third crop cycle. The split plot of mucuna beans and mixed vegetables was not to be. Farmer agreement notwithstanding, they failed to complete the activities required for the second crop in time to include a third crop. Though disappointed about the cover crop component, researchers realized then that planting vegetables in the *ladang* was not realistic given the poor soil.

Plans for Year Two

Bill and Joan met with the collaborating farmers in August to plan the year's program and review the previous years trials. That farmers preferred a much simplified cropping system was both obvious and welcome to the researchers: rice followed by peanuts. The farmers' other big con-

Table 6-2

Peanut Yields of Ten Cooperating Farmers, Sitiung V

Initial Fertility Treatment	Peanut Yield (Qu/ha)
1. None: Control	4.1
2. Government treatment (100 kg/ha each, urea & TSP)	4.9
3. Rock phosphate (800 kg/ha + treatment 2)	5.1
4. Lime (2.5 t/ha) + urea (100 kg/ha) + TSP (200 kg/ha)	6.9

Source: Wade et al. (1985b), Table 1. Peanut Year 1 data (units changed from kg/plot to qu/ha).
Notes: The least significant difference (LSD) at 0.05 level is 1.0.
Qu (quintal) = 100 kg.

cern was the control plot. They considered it a complete loss and insisted that some treatment be planned for it. Bill and Joan agreed. Under the conditions of transmigration, the control plot was also experimental. They described to the farmers a treatment from another area of Sitiung (Sitiung II) which had demonstrated substantial yield increases from adding organic matter to soil planted to rice. Why not use green leaf manure (GLM) on the control plots, and see what happened in Aur Jaya? The farmers were amenable to this suggestion, and *Calopogonium muconoides* was brought from a nearby rubber plantation for application to control plots, at a rate of 10 tons fresh material per hectare.

The government fertilizer treatment 2 was limed at 3.5 tons per hectare (in accordance with a national liming program newly underway in Sitiung), and 100 kilograms per hectare each of urea and TSP. Treatment 3 remained unchanged with a reapplication of urea and TSP. Treatment 4 was an additional 0.5 tons per hectare of lime as a maintenance application; urea and TSP at 100 and 200 kilograms per hectare respectively; and potassium chloride (KCl) at 50 kilograms per hectare. Tillage was no longer a management question at this time because all farmers willingly tilled after the first rice crop and each crop thereafter (the Minang cooperators had left Sitiung V and returned to their home village). The plan and implementation for year one and the plan for year two are summarized in Table 6-3.

TIME ALLOCATION STUDY

Rationale

The team knew that many promising soil management innovations and practices are not adopted by farmers. Joan pointed out that this is often because the efforts required to implement the innovations and practices conflict with the schedules and work habits of the farming household. In order to find out how Sitiung farm families spent their time, she planned a time allocation study (TAS). She hoped this would also shed light on women's activities.

The objectives of the study were to ascertain the existing division of farm labor by gender and age, to determine important seasonal variation in activities, and to maintain ongoing communication between the research team and farming families.

Methodology

Joan chose a method developed by Allen Johnson (1975, 1978), which entailed recording on-the-spot observations of the activities of household

Table 6-3

Exploratory On-farm Trial in Farmers' Fields

First Year		
Treatment Plan		
1. Control: No fertilizer or lime		
2. Government treatment: 100 kg urea + 100 TSP/ha		
3. 800 kg rock phosphate + 100 kg urea + 100 TSP/ha		
4. 2.5 t lime + 100 kg urea + 200 TSP/ha		
Cropping Pattern Plan		
Cycle 1	Rice intercropped with cassava	
Cycle 2	Mung beans	
Cycle 3	1/2 mucuna beans; 1/2 vegetables	
First Year Plan as Implemented		
	Field A	Field B
Cycle 1	White rice with corn	Red rice with corn
	Some hoed	Some hoed
Cycle 2	Peanuts	Chilies
Cycle 3	Not completed	
Second Year		
Treatment Plan		
1. Control treatment modified: Green leaf manure incorporated at 10 t/ha		
2. Government treatment modified: Addition of lime at 3.5 t/ha		
3. Unchanged		
4. 0.5 t lime + 100 kg urea + 200 kg TSP + 50 kg KCl/ha		
Cropping Pattern Plan		
Cycle 1	Red rice	
Cycle 2	Peanuts	
	Use of rice straw monitored	

members, with observations scheduled via a four-way randomization: by household, by time of day, by day of the week, and by month. Transportation problems necessitated grouping scheduled visits into blocks of time, so Joan modified the four-way randomization and used a rotating schedule.

The hours of observation in all cases were from 7 AM to 8 PM. Visits to households were just long enough to record the needed information on the form. A visit to a household involved, insofar as possible, direct observation of the household members and recording of age, sex, and activity of each household member (ideally at the instant before the researcher's presence was noted). Other data, such as ethnic group, religion, or reproductive status, were incorporated into the data collection process. Recorders simply wrote down on a form what activity was being performed by each person at home. Where one person was performing more than one activity, dual activity was recorded.

Several junior male researchers conducted interviews as well as Joan. The team conducted the study over a one-year time period in Sitiung I (Piruko) and Sitiung V (Aur Jaya). In Aur Jaya, from a total of three hundred households, 585 visits were made between 10 September 1983 and 8 September 1984, and 2,537 individual observations were recorded. In Piruko, from a neighborhood of seventy-five households, 650 visits were made between 12 November 1983 and 31 October 1984, and 3,056 individual observations were made.

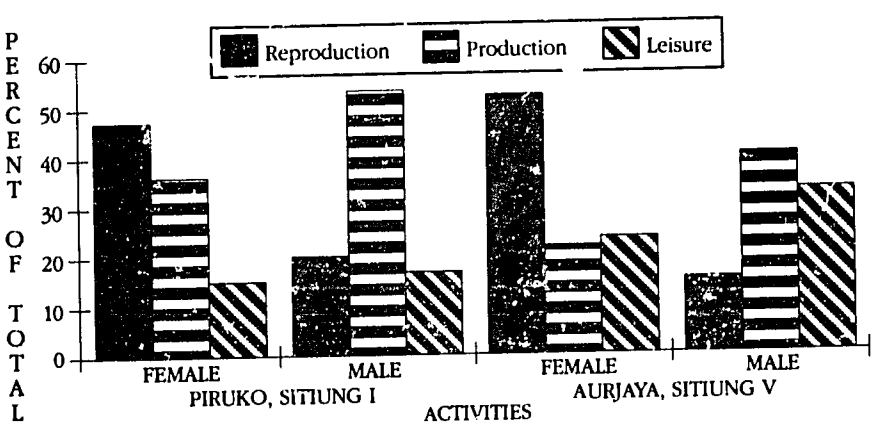
Findings

The results from the TAS were coded and analyzed. The coding scheme developed provided three levels of generality: (1) every kind of activity that was observed could be listed; (2) an intermediate grouping was coded (e.g., agricultural labor, animal care, food preparation); and (3) a tripartite division was made into productive (activities that add value), reproductive (maintenance activities), and leisure activities. Appendix 6-C shows the frequency by gender of all the reproductive, productive, and leisure activities recorded during the study. The differences between men and women and between Sitiung I and Sitiung V in these categories is shown in Figure 6-2.

The percent contribution of men and women to productive activity both on and off the farm is shown in Figure 6-3. The results of the TAS could be used to estimate the amount of time spent in a specific activity.[5] Joan was pleased with the results of the TAS because it provided statistical evidence that women were involved in farming.

Figure 6-2

Percent Frequencies of Observations of Reproduction, Production, and Leisure Activities



FORAGE TRIALS

Rationale

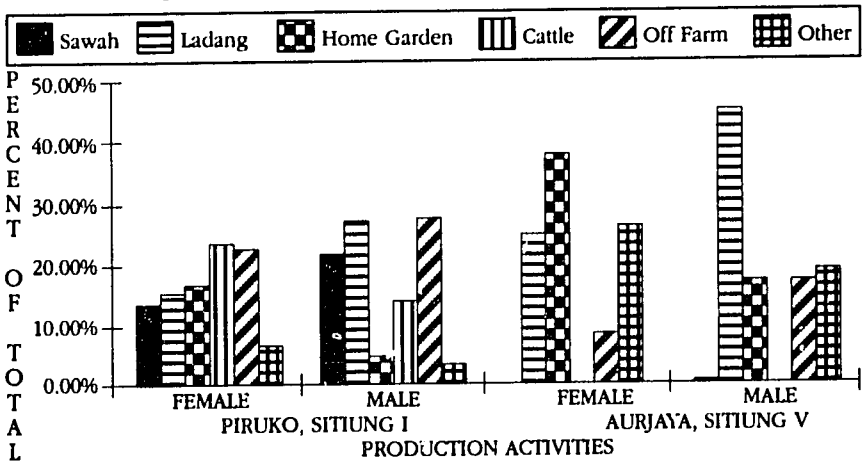
One of the soil scientists had previously worked with the aluminum-tolerant legumes and grasses that the Centro Internacional de Agricultura Tropical (CIAT), in Cali, Colombia, had collected from areas naturally acid and with low fertility in Africa, South America, and Southeast Asia (see Appendix 6-D). Many of these species grow well in soils with pH of 4.0 to 4.5 and with aluminum saturation of greater than 75 percent. Given the extremely acid and infertile soils of the area, these species seemed from early on to be promising candidates for various purposes in upland farming systems in Sitiung, and the soil scientist agreed to collaborate with CIAT in conducting trials on these species.

Preliminary Results

Stage I species trials (according to the CIAT Regional Trials B program) were initiated in December as researcher-managed trials on farmer fields. The trials were designed to take a first look at relatively large numbers of species of candidate grasses and legumes. Several of the species died of various causes including disease, insect attacks, and lack of adaptability to the highly acid soil conditions. Some of the species which appeared to be relatively well adapted were unsuitable because of excessively woody, nonpalatable tissue. Some of the species demonstrated a prostrate, viney growth habit while others displayed an erect growth habit.

Figure 6-3

Percent Frequencies of Observations of Types of Production Activities



There were early indications from some farmers that erect-type forage plants would be more suitable and were preferred—presumably because of greater ease of hand cutting and carrying. Transmigrant farmers in the area, following their practice in Java, preferred to confine their animals and carry forage to them rather than to allow the animals to graze on their own. This meant forage materials amenable to cut-and-carry management would be preferable. Although scientifically inconvenient, farmer interest in the endeavor was indicated by their making off occasionally with cuttings from the experimental plots.

INCOME AND FOOD PRACTICES SURVEY

Rationale

During the discussion of agronomic aspects of the project, related questions began to emerge. How do family resources relate to soil management practices? What resources do transmigrants currently use in obtaining family necessities such as food? How are people securing their food and what are they eating? How does this fit with nutritional needs? To answer these questions, the team brought in one outside female consultant and two Indonesian nutritionists, one male and one female, to undertake a study of income and food practices.

Methodology

In April 1984, eighty transmigrant families in Sitiung were surveyed: three groups of twenty randomly selected families from Sitiung I, II, and V, and the families of the twenty cooperating farmers in Sitiung V. The survey combined a modified dietary recall on total families with observations and interview data. Attempts to collect physical-health status indices were not successful. Households were visited on two successive days, the first visit around midday and the second in the evening. A variety of questions related to agricultural production, subsistence, and income over the previous year were also asked.

Findings

Families ate two major meals each day with only a light snack for breakfast, though most cooking was done in the morning. All groups generally consumed rice as their major staple; 95 percent of the households produced rice and 85 percent reported consuming all the rice they grew. Cassava was used if necessary as a second choice; 70 percent consumed it four or more times per week. Soy products, a source of protein, calcium, and vitamin B,

were important in the diets of all transmigrants. Corn consumption was rare. Vegetables and fruits, sources of vitamins A and C, varied in importance according to the ethnic group with Sundanese eating the widest variety of green vegetables and Javanese eating the fewest. Overall, reported vegetable consumption was very low and fruit consumption minimally higher. All groups consumed bananas. Peanuts and chilies were also eaten fairly frequently. Peanuts, chilies, soybeans, bananas, and citrus were also marketed. Few consumed milk or milk products after breast feeding ended.

Sitiung I and II households reported an average of more than one cow (part of a government allocation program), one goat, and seven chickens per household. The ungulates (never milked) were butchered for meat for special occasions. No livestock were reported for Sitiung V. Fish, poultry, and eggs were eaten in small amounts when available.

A partial analysis of the foods consumed as indicated by the recall survey was done. The analysis indicated that the population was, on the average, marginally adequately nourished. There was not much difference between settlements. All transmigrants appeared to be nutritionally less well-off than the indigenous Minang population, but somewhat better off than they had probably been in Java. The researchers were struck by the lack of variety in the cropping patterns of the transmigrants. Qualitatively, they judged Sitiung gardens to provide far less diversity than comparable gardens on Java.

Households varied in size from one to nine members, with six the mode. All household members gathered wood for fuel, kerosene was used for light, and well water was easily accessible to the large majority. All family members carried water, but females tended to carry it more often.

Annual household incomes ranged from Rp 112,600 to Rp 2,702,400. Modal real income was between Rp 113,700 and Rp 563,000 (47 percent of families). Sources of reported earned income, sales versus consumption of agricultural production, and the sources of agricultural production are reported in Tables 6-4, 6-5, and 6-6.

DISCUSSION OF FUTURE RESEARCH

During the year, team members met informally—in the field, at their offices, in their homes—and discussed future work. A United States based review team had come in March, and acrimonious discussions had occurred about the utility of farming systems research vis-à-vis traditional soil science. Joan's university and the Indonesian government were in full support of the farming systems approach, but Bill's university expressed serious reservations. Outside reviewers were split. Though Bill remained committed to the farming systems approach, he felt some responsibility to be responsive to his own university's concerns. Still, much component research was already underway in Sitiung.

Table 6-4

Sources of Reported Earned Income per Family per Year in Three Sitiung Locations[a]

Location	Home Industry	Wage Labor	Agricultural Production[b,c]	Totals
Sitiung I	87 (22)	163 (42)	140 (36)	390
Sitiung II	95 (11)	526 (59)	267 (30)	888
Sitiung Va[d]	28 (3)	737 (86)	88 (10)	853
Sitiung Vb[d]	42 (11)	157 (43)	168 (46)	367
Mean	63 (10)	396 (63)	166 (27)	625

Source: Colfer, Evenson, Fahmuddin, Gill, Wade, and Chapman (1985).
[a]Rupiah in 1,000's, percent in parentheses.
[b]The value of crops was estimated using then-current prices in the nearest markets for the commodities grown. Crops consumed were also assigned market values.
[c]Differences in totals between tables 6-4, 6-5, and 6-6 due to rounding.
[d]Sitiung Va are the randomly selected farmers; Sitiung Vb are the cooperating farmers.

Table 6-5

Subsistence versus Sales of Agricultural Produce per Family per Year in Three Sitiung Locations[a,b,c]

Location	Produce Consumed[d]		Produce Sold[d]		Totals
Sitiung I	112	(80)	28	(20)	140
Sitiung II	157	(58)	112	(42)	269
Sitiung Va[e]	57	(61)	36	(39)	93
Sitiung Vb[e]	78	(46)	91	(54)	169

Source: Colfer, Evenson, Fahmuddin, Gill, Wade, and Chapman (1985).
[a]Reported production from garden, *ladang*, and paddy.
[b]Rupiah in 1,000's, percent in parentheses.
[c]Differences in totals between tables 6-4, 6-5, and 6-6 due to rounding.
[d]The value of crops was estimated using then-current prices in the nearest markets for the commodities grown. Crops consumed were also assigned market values.
[e]Sitiung Va are the randomly selected farmers; Sitiung Vb are the cooperating farmers.

On this rainy November day, the team was gathered to begin planning future work. The second set of collaborator farmer trials was underway and the team had begun looking at the preliminary analysis of the TAS. Based on all the research carried on over the past year as well as the team members' own observations, it was clear that location, ethnic, and gender differences were all important variables in determining farmer practices. Did they know enough about any of these variables? How could this knowledge be incorporated into future research? Where should their efforts focus for improving and understanding soil management as well as farm productivity and income?

Table 6-6

Value of Agricultural Produce per Family per Year in Three Sitiung Locations[a,b,c]

Location	Garden	Dry Field	Paddy	Total Value
Sitiung I	36 (28)	6 (3)	88 (68)	130 (100)
Sitiung II	89 (33)	180 (67)	1 (—)	270 (99)
Sitiung Va[d]	53 (60)	35 (39)	— (—)	88 (99)
Sitiung Vb[d]	74 (44)	94 (56)	— (—)	168 (99)

Source: Colfer, Evenson, Fahmuddin, Gill, Wade, and Chapman (1985).
[a]Reported production from garden, *ladang*, and paddy.
[b]Rupiah in 1,000's, percent in parentheses.
[c]Differences in totals between tables 6-4, 6-5, and 6-6 are due to rounding.
[d]Sitiung Va are the randomly selected farmers; Sitiung Vb are the cooperating farmers.

STUDY QUESTIONS

1. What are the roles of men and women in Sitiung?
2. There are three primary types of land use in Sitiung. What are the products of each of these systems and what are the uses of this output?
3. What are the factors influencing crop production practices in Sitiung?
4. What problems and/or opportunities for improving agricultural production and family life in Sitiung can be identified so far? Propose some promising research possibilities and identify to whom they are targeted.
5. Evaluate the involvement of men and women farmers in the Tropsoils project during the first fifteen months. What strategies might increase the involvement of women farmers? How does this fit with the project's objectives?

NOTES

1. A number of people contributed to this case study. It was, indeed, a dynamic group effort. Each person's contributions are much appreciated.

   Vickie A. Sigman provided leadership. She visited the project in Sitiung and worked there in close collaboration with resident Carol Colfer to outline the case and to identify project documentation to be rewritten or summarized for inclusion in the case. She coordinated the efforts of the interdisciplinary group of authors based at Hawaii and she was the principal writer for the first section of the case. Carol Colfer carefully reviewed drafts of the case, suggested improvements, and provided additional data as necessary. She acted as liaison between University of Hawaii-Manoa and Sitiung, Indonesia. She was principally responsible for writing section two.

Kathleen Wilson and Michael Wade coauthored the part on Cooperator Farmer Trials. This part is based on and draws from field research conducted in Sitiung by Michael Wade, Fahmuddin Agus, and Carol Colfer. Vickie Sigman and Carol Colfer coauthored the time allocation part of the case (based on Colfer's field research). Russell Yost authored the part of forage trials which drew from field research that John Thompson, Carl Evensen, Djoko Santoso, and he conducted in Sitiung. Barbara Chapman authored material on food practices and income, and Stacy Evensen contributed information on home gardens. Marian Rauch coordinated final editing. She and Kathleen Wilson contributed to the case teaching notes.

Field research was carried out with funding from the United States Agency for International Development (USAID), the Centre for Soil Research in Bogor (CSR), University of Hawaii (UH), and North Carolina State University (NCSU). These organizations also provided various kinds of administrative, technical, and backup support to project members in Sitiung. Besides this, they have cooperated willingly with our efforts to produce this case study. Special thanks go to Dr. Sudjadi (Director, CSR), Dr. Putu Gedjer (Site Coordinator, CSR), Dr. Goro Uehara (Principal Investigator, UH), Dr. Gordon Tsuji (Project Administrator, UH), Dr. Charles McCants (CRSP Management Entity), Dr. Pedro Sanchez (Principal Investigator, NCSU), and Ms. Joanne Hale (Project Officer, USAID-Jakarta). Perhaps more important than all of the above have been the cooperation and contributions of Sitiung's inhabitants, who welcomed the Tropsoils team into their communities and exhibited consistent patience with the strange ways of these alien Americans in their midst.

Authors utilized a range of documentation from the projects as the basis for the case. The primary documents used are listed in the References section.

2. The Tropsoils Project was a collaborative project between the Indonesian government and USAID under the framework of a Collaborative Research Support Project (CRSP). The Indonesian government contributed administrative leadership and support from the Centre for Soil Research, as well as funds, vehicles, office facilities, living quarters, and fifteen scientists and technicians. The contribution of the United States institutions (University of Hawaii and North Carolina State University) consisted of an on-site field team, university-based backstopping, and cooperative funding.

3. "*Sondeo*" is a Spanish word used to describe an interdisciplinary, rapid diagnostic survey based on informal interviews.

4. "*Sawah*" are submerged rice fields in which the land is prepared so that water stands in the field. The water may come from rain or irrigation. "*Ladang*" are upland fields in which rice is planted like maize or corn and there is no standing water.

5. For example, in Piruko there are 215 observations of people getting grass. There are a total of 3,050 observations. To convert the frequency of observations to time the calculations look like the following:

$$\frac{215}{3{,}050} = .070$$

$$.070 \times 13 \text{ hours} = .92 \text{ hours}$$

$$.92 \times 60 = 55 \text{ minutes}$$

Applying the formula separately to women's and men's grass collecting, the times are 24 and 30 minutes respectively. Thirteen hours is used because it is the number of hours in the observed day.

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Appendix 6-A: Soil Science Overview

Soil Management

Soil scientists are concerned about, among other things, soil management. Soil management is the way in which people use the soil to produce food, fiber, and forage. In a soil-management system, there are two primary goals. One is to prevent soil deterioration such as excessive erosion, fertility depletion, and salt accumulations. The second goal is to improve the soil system in order to increase crop production. Conservation of moisture and increased water-use efficiency by hoeing and/or proper fertilization are examples reflecting this second goal.

Soil Fertility

Soil management and soil fertility are related. There are two major dimensions to soil fertility: potential and actual fertility. In other words, soil analyses try to answer the question: How much nutrient can the soil hold and how much is it holding right now? Potential fertility refers to the capacity of the soil to supply plants with elements from the soils' inorganic and organic reserves. This is accomplished through the processes of weathering and microbial mineralization. Cation exchange capacity (CEC) is a quantitative measure of the capacity of the soil to retain positively charged chemical elements such as calcium, magnesium, and potassium. Factors influencing CEC include pH (alkalinity), soil clay, and organic matter. The CEC (the potential) does not necessarily tell you how much of these nutrient elements are present (the actual).

Specific analyses for each nutrient are necessary to measure actual fertility. Actual fertility refers to the soil's supply of nutrient elements commensurate with plant needs. Plant roots only absorb dissolved nutrients as ions present in the soil solution. When depleted, ions are primarily replenished by processes of cation release or dissolution.

Nutrients

The three essential nutrients are: N, nitrogen; P, phosphorus; and K, potassium. Commercial fertilizers identify the percentage of these nutrients present in the fertilizer. For example, of the three nutrients, a bag of fertilizer labeled 15–30–15 has 15 percent nitrogen, 30 percent phosphoric acid (CP_2O_5) and 15 percent soluble potash (K_2O) Other nutrients, all

essential to some plants but not all required for all plants, are calcium (Ca), magnesium (Mg), sulfur (S), boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), zinc (Zn), sodium (Na), cobalt (Co), and silicon (Si).

Soil scientists are concerned about a wide-ranging spectrum of soil-plant interactions. The supply, availability, and uptake by plants of the nutrients listed above is one many-sided focus of the work of soil scientists. For example, where the supply of nutrients is deficient or insufficient, there are plant growth problems. Where the supply of these nutrients is abnormally high (toxic or excessive), there are other sets of plant growth problems.

Nutrient-related Problems in Sitiung

A major problem in Sitiung involves excessive levels of soluble aluminum, which is the main plant-growth reducing substance in the soil. This is related to the problem of soil acidity. In Sitiung, soluble aluminum is in the soil solution and affects the plant roots directly in several ways. One of the most obvious ways is that root growth is impaired. A second way is that the efficiency of the plant root to absorb nutrients and water is sharply reduced if the plant is aluminum sensitive and there is a lot of aluminum in the solution.

There are a variety of ways to address problems of aluminum toxicity and soil acidity. One approach is to plant crops tolerant to high concentrations of aluminum in the soil solution. Another is to add lime—generally such materials as calcium hydroxide, calcium carbonate, calcium-magnesium carbonate, and calcium silicate slags. Adding lime reduces acidity and aluminum toxicity. This sounds simple. It is not. The addition and incorporation of tons of lime materials with the soil requires a great deal of time and labor in a nonmechanized system as in Sitiung. Also a significant infrastructure must be in place to process, transport, and distribute the lime materials.

Use of acid-tolerant crops, amendment of soil acidity by liming, fertilization with phosphorus and nitrogen, and increasing levels of exchangeable cations all appear necessary to sustain crop production. Suggested management practices for all include liming, phosphate fertilization, and incorporation of organic matter and crop residues.

Fertilizers given or sold at subsidized prices by the Indonesian government to Sitiung migrants included urea, a nitrogen fertilizer, and TSP, which contains 40–50 percent P_2O_5 and is rapidly soluble compared to rock phosphate.

Site-specific Analysis: Sitiung I

The soils in this area are fairly level inceptisols and oxisols, but they are acid and infertile. Thus, crops like flooded rice and cassava can be grown

successfully, but it is very difficult to grow crops demanding better fertility, like soybeans, corn, and mung beans, without improving the fertility first. The soils are deep and well drained. They have excellent physical properties and good tilth. They are low in bases and high in aluminum. They are also low in phosphorus and have a moderately high phosphorus-fixation capacity. Though the clay content is high, they are so well aggregated that they behave very much like sandy soils. Because of this and the stunted root growth due to aluminum toxicity, water stress is often a limiting factor in plant growth and crop yield. Sitiung I land was originally cleared by bulldozing and would sustain virtually no crop growth for several years, though farmers maintain that the land improves yearly now.

Site-specific Analysis: Sitiung V

These soils are steeper, more highly dissected ultisols and have a shallow topsoil of only fifteen centimeters. The topsoil is sandy with a relatively low clay content (25–30 percent). The clay content rapidly increases with depth, reaching 50–60 percent by thirty to fifty centimeters. The soils have even lower bases than the soils in Sitiung I. They are high in aluminum and very phosphorus deficient. But they do have a low phosphorus-fixation capacity. Like all the soils of the area, it is difficult to grow field crops that require more than a very low fertility level.

Appendix 6-B: Modified *Sondeo* Report

A. FARMING SYSTEMS

Sawah: Wet-Rice, Irrigated

The *sawah* fields are only in Sitiung I, but an irrigation scheme is underway in Sitiung II. The Minang have some *sawah* fields by the river. There are usually two rice crops planted in Oct./Nov. and Mar./Apr.; harvest is about three months later. Timing depends on a government-determined irrigation schedule. The Minang don't use fertilizer, and have yields of 2 t/ha. If transmigrants can afford fertilizer, they use 100 kg/ha TSP and urea, and have yields of 3–4 t/ha.

Ladang: Upland Fields, Rain-fed

Everyone has one hectare *ladang* land under the transmigration scheme. The *ladang* is usually located 1–2 km (30–60 min walk) from house. There are three main cropping patterns.

1. *Monocrop rice.* Plant in Sept./Oct.; harvest Feb./Mar. Yields of 1 t/ha unmilled. Followed by fallow.

2. *Intercropping with rice.* Sometimes cassava, which grows well but appears to be a stigmatized crop. East Javanese traditionally consume cassava as a "stretcher" for rice, among other things.

3. *Second crops.* In more fertile *ladang* lands: plant rice in Sept./Oct., harvest rice in Feb./Mar., followed by planting peanuts, soybeans, mung beans, or cowpeas for harvest about three months later. Peanut yields are over 600 kg/ha. Corn is intercropped on some *ladangs.*

Pekarangan: Home Garden

There are home gardens one-quarter of a hectare around almost everyone's home, but they seem to be more established in the older settlements. There appears to be a wide diversity of vegetables, fruit trees, cassava, pulses, and even some rice with cash crops of clove, coffee, and sugar cane. The Minang have primarily mature perennial species in their gardens.

Livestock

Cattle are fairly widespread in older settlements. They are fed in their stalls with cut grass or are allowed to graze on public lands. The Javanese view cattle as financial security. The Minang graze water buffalo.

Rubber

The Minang tap rubber trees. This is an important source of income because their plantings are part of a rubber planting scheme, and there is a processing factory in the Sitiung area.

B. PROBLEMS

General

Low yields from agricultural production were due to a combination of low soil fertility, soil acidity, uneven rainfall, soil variability, lack of timely agricultural inputs, few quality seeds, pests, diseases, and type of land-clearing method.

More Specific

1. Different settlements receive from the government, through the government cooperative, different but modest allotments of fertilizer. The difference is probably based on time of settlement.

2. Rice: rice blast or seedling fly major problem. Farmers all emphasize importance of rice.

3. Soybeans: low yields due to pests, high aluminum saturation

4. Corn: wild pigs and rats major problems; also downy mildew (Ridomil can control mildew but farmers say it's too expensive.)

5. Mung beans: sensitive to aluminum, need high lime levels

6. Livestock: no forage plantings nor improved pastures

7. Extension services: appears there is limited interaction between farmers and extension service

8. Availability of seed is sometimes problematic, although farmers save seed from year to year.

C. OPPORTUNITIES

1. Peanuts tolerate unlimed soils.

2. Cassava appears to do well.

3. Rubber and other cash tree-crops as source of income, and for erosion control.

4. Home gardens

5. Forage and pastures

6. Cowpeas and mung beans tolerate drier weather.

7. Good opportunity to learn from Minang as they are surviving fairly well in this environment.

8. Home industry, primarily done by women, includes drying cassava chips and making *tempe* (soybean cakes) for sale.

Appendix 6-C: Results of the Time Allocation Study: Frequencies of Observations of Activities by Gender

		Piruko		Aur Jaya	
		F	M	F	M
Reproductive Activities					
101	Eat	76	63	57	51
104	Drink	0	0	1	0
200	General food preparation	0	0	2	0
201	Cook	68	12	93	5
202	Hand hull rice	2	0	1	0
203	Get water	6	1	4	1
204	Shop	32	15	15	7
205	Shoo dog/cat	0	1	0	0
206	Cut/peel food	33	1	7	3
208	Wrap food	19	3	0	0
209	Clean food	4	0	8	1
210	Pound food	3	1	8	0
211	Get firewood	23	17	3	2
212	Wash food	0	0	0	3
213	Smoosh food	0	0	1	2
300	General childcare	42	18	99	19
301	Hold a baby	5	2	21	6
302	Feed/nurse baby	9	0	18	0
303	Watch/teach children	58	20	25	2
304	Carry on back/hip	29	2	44	4
305	Care for sick/old or massage	2	1	7	1
306	Swing baby	0	0	1	0
411	Sew	1	0	2	0
412	Maintain machines	0	3	1	6
416	Sharpen knives/tools	0	0	0	4
706	Sick	5	2	4	7
801	Bathe	42	36	18	19
802	Wash dishes	8	1	9	0
804	Wash/dry/fold clothes	30	6	17	3
805	Elimination	0	0	0	2
806	Sweep floors	17	1	4	1
807	Wash house	1	0	0	1
808	Clean village	1	2	0	0

Continued on next page

Appendix 6-C, *continued*

		Piruko F	Piruko M		Aur Jaya F	Aur Jaya M	
Reproductive Activities, *continued*							
809	Get dressed	4	3		8	4	
810	Tidy house	1	0		30	6	
811	Seek fleas	0	0		1	1	
812	Clean yard	67	7		3	0	
813	Burn trash	0	1		0	0	
814	Iron	1	0		0	0	
815	Wash a baby	0	0		1	0	
907	Attend a funeral	0	1		0	0	
1001	School in village	145	151		52	53	
1002	School away	0	0		4	3	
1003	Study	29	19		3	5	
1004	Extension course	0	1		0	3	
1005	Learn from elders	0	0		0	1	
1006	Watch television	11	15		0	0	
Total reproductive activity		774	406	1,180	572	226	798
Productive Activities							
402	Build structure/fence	0	6		0	10	
404	Make roof shingles	0	0		0	1	
406	Woodcutting	0	0		0	4	
410	Make knife/hoe	0	1		0	1	
423	Fix animal house	0	1		0	1	
425	Make toys	0	0		0	2	
426	Make basket for grass	0	1		0	1	
502	Fish	0	2		0	8	
600	Unspecified agriculture	3	5		4	6	
601	Weed *ladang*	4	0		3	10	
602	Scare away pests	0	2		0	0	
603	Check *ladang*	3	9		3	10	
604	Harvest *ladang*	25	27		15	13	
605	Travel to *ladang*	10	28		7	11	
608	Bring rice from *ladang*	23	18		0	0	
609	Clear forest/*ladang*	0	0		1	4	
610	Fell large trees/*ladang*	0	0		0	2	
611	Dry rice/*ladang*	1	1		0	0	
612	Debranch felled trees in *ladang*	0	0		0	3	
613	Thresh *ladang*	0	0		0	1	
614	Shell crops/get seeds	0	0		19	8	
615	Postburn woodgather in *ladang*	0	0		0	2	
616	Agricultural planning	0	0		3	3	

Continued on next page

Appendix 6-C, *continued*

		Piruko		Aur Jaya	
		F	M	F	M
Productive Activities, *continued*					
618	Plant *ladang*	11	9	8	22
619	Hoe *ladang*	7	72	10	65
620	Burn in *ladang*	0	0	1	11
621	Fertilize *ladang*	0	0	1	3
622	Spray *ladang*	0	2	1	1
650	Weed *sawah*	14	4	0	1
651	Hoe *sawah*	6	83	0	0
652	Plough *sawah*	0	18	0	0
653	Plant *sawah*	27	2	0	0
654	Travel to *sawah*	2	9	0	0
655	Spray *sawah*	0	3	0	0
656	Harvest *sawah*	1	2	0	0
657	Transplant	0	1	0	0
658	Check/guard *sawah*	1	2	0	0
659	Carry rice from *sawah*	2	4	0	0
675	Hoe home garden (HG)	5	14	4	24
676	Plant home garden	20	10	10	12
677	Burn home garden	0	1	2	3
678	Scare pests/HG	0	0	2	0
679	Watch crops/HG	2	1	2	2
680	Harvest home garden	30	5	23	10
681	Dry in home garden	24	6	6	7
682	Spray home garden	0	0	0	1
683	Fertilize home garden	0	0	1	1
684	Weed home garden	3	0	6	3
685	Unspec. average labor/HG	1	1	0	0
686	Carry rice/HG	1	0	0	0
1200	Unspecified wage labor	1	49	0	3
1201	Work for company	0	5	0	0
1202	Sell at home	0	3	6	5
1205	Carpenter	0	4	0	0
1206	Buy to resell	1	1	1	2
1207	Resettlement or trans-migration worker	0	0	0	1
1209	Average wage labor	16	27	1	5
1212	Office work	6	5	0	1
1214	Plywood or sawmill	0	1	0	1
1215	Transport for sale	1	1	0	0
1216	Get wood with truck	0	0	0	6
1217	Teacher	3	0	2	2
1218	Get trans. subsidy	0	0	4	6
1219	Maid/waiter	36	7	8	1
1220	Sell wood from forest	0	1	0	20

Continued on next page

Appendix 6-C, *continued*

		Piruko F	Piruko M		Aur Jaya F	Aur Jaya M	
Productive Activities, *continued*							
1221	Seek work	0	0		0	2	
1222	Tree crops factory or plantation	0	6		1	5	
1223	Construction	1	34		0	0	
1224	Sell at market	24	7		0	0	
1225	Tailor	0	6		0	0	
1305	Make lumber/forest	0	0		0	1	
1307	Glean food/leaves	4	1		0	1	
1308	Collect meranith for glue	0	0		0	1	
1401	Chicken care	0	0		3	1	
1402	Make fish pond	0	0		0	2	
1403	Get grass	95	120		1	0	
1404	Cattle care	5	3		0	0	
1405	Herd	12	15		0	0	
1406	Harvest fish pond	1	0		0	0	
Total productive activity		432	646	1,078	159	333	492
Leisure Activities							
700	Unspecified leisure	126	90		48	67	
701	Rest	1	3		21	30	
702	Sleep	53	71		68	82	
704	Cry	7	11		4	4	
705	Play	114	145		355	370	
901	Informal visit	20	12		17	23	
902	Attend meeting or get letter	0	6		0	3	
905	Visit Koto Padang*	0	0		51	44	
906	Unstable residence*	0	6		5	1	
909	Attend party	4	10		6	8	
910	Visit Java*	5	4		51	57	
911	Read Koran	1	2		5	7	
912	Pray	1	0		2	9	
913	Go to Mosque	29	37		1	2	
1101	Dance	0	0		3	0	
1103	Sports	10	23		2	1	
1104	Write a letter	1	0		0	0	
Total leisure activity		372	420	792	639	708	1,347

Source: Colfer, et al. (1984).
*These people were not available for observation, so including their activities in leisure is arbitrary.

Appendix 6-D: General Information on Forages

Part of the work of the Centro Internacional de Agricultura Tropical (CIAT), Cali, Colombia, is identifying and improving species and varieties that exhibit tolerance to aluminum toxicity in soils. As an International Agricultural Research Center, CIAT's mandate includes testing these varieties for their adaptability to differing agroclimatic and edaphic (soil) conditions. The forage crop trials conducted in Sitiung are a collaborative effort with CIAT and are conducted to test the adaptability of initially screened varieties.

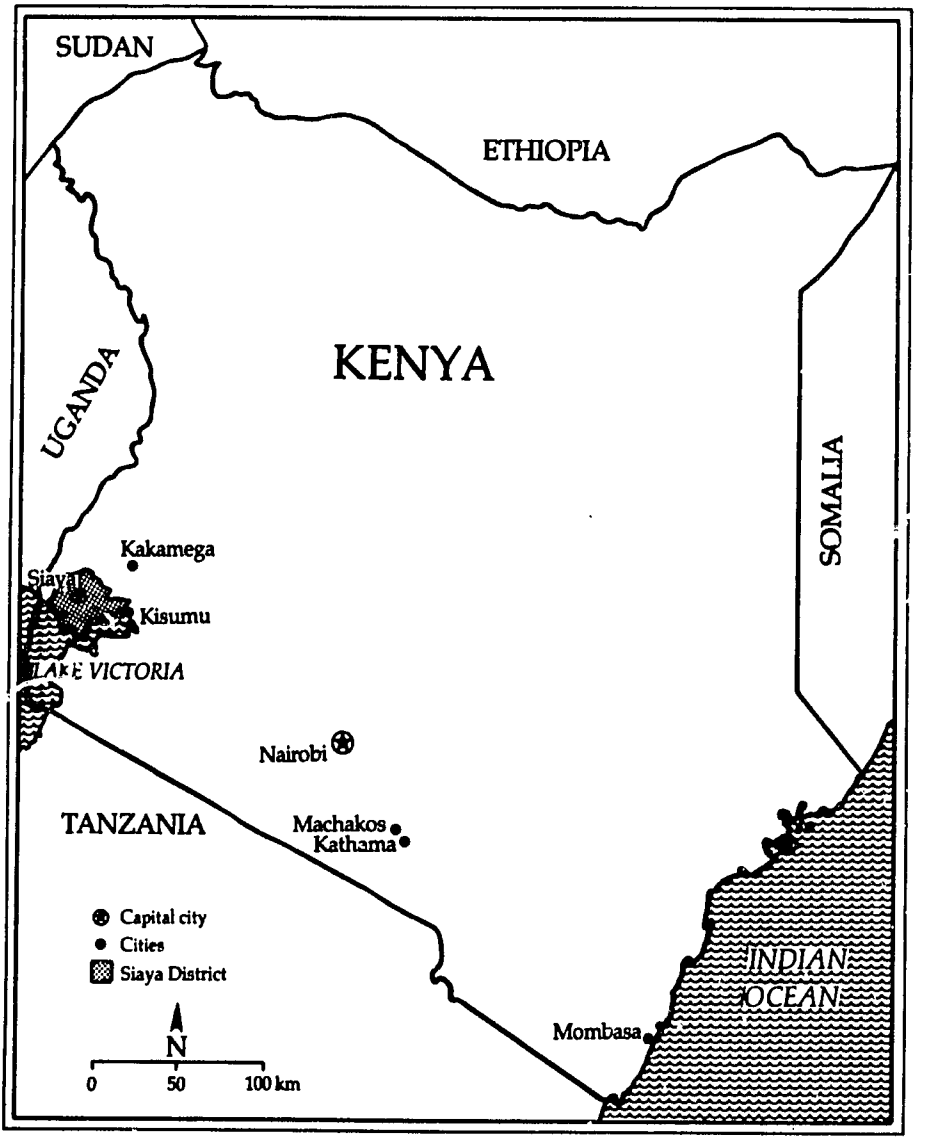
Forage crops include annual and perennial grasses and legumes consumed by livestock as pasture, range, and stored feed. Legumes, generally deep-rooted, are nitrogen-fixing plants, with the unique ability to utilize nitrogen from the air through the activity of symbiotic bacteria. The bacteria grow in nodules on the plant roots, making nitrogen available to the plant. Additionally, legumes grown in intercropping or rotation systems help to provide nitrogen for use by other plants.

As protective vegetative cover, forage crops act to dissipate the energy of rain drops and thus reduce soil erosion and increase the capacity of soil to take in water (rate of infiltration). Those concerned with soil erosion and conservation utilize this aspect of forage crops. Soil under a grass cover has improved infiltration and reduced runoff as compared to barren soil and intertilled crops.

The CIAT trial designed to be installed in Sitiung, CIAT Regional Trials B, was part of a series of experiments designed to evaluate forages through several steps. Many of the species to be tested in the forage trial had never been grown in the region before or even in Southeast Asia. Species should be well evaluated before distributing to farmers. In the past, introductions such as these have inadvertently been the source of new noxious weeds. Hence, careful observation and evaluation of the species is quite important, as illustrated in the following steps:

1. Determine if forage species showing promise in analogous ecosystems can grow in the region. This is a stage I trial, usually for one season.
2. Determine production levels in small plots and observe particular susceptibilities to local diseases and pests. These trials may continue for more than one season to permit longer term evaluation and preliminary estimates of fertilization and management requirements.
3. Determine production levels in large management units—similar to those which would actually be used by the farmers. These trials would usually be evaluated by grazing animals, and be long term, permitting estimation of stability and maintenance requirements.

Figure 7-1
Map of Kenya Showing Siaya District



Chapter 7

Kenya

Agroforestry Extension and Research: A Case Study from Siaya District

HILARY SIMS FELDSTEIN, LIANNE E. ROCHELEAU
AND LOUISE E. BUCK

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Part 3 After Eighteen Months (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

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Kenya: Part 1
Planning

"This is a great opportunity to put into practice our ideas about community participation and combining extension with research." Anna leaned back at her desk and smiled at her friend who was doing research at the International Council for Research on Agroforestry (ICRAF).[1] David had been pleased to hear that Anna had been asked to develop a plan for CARE Kenya[2] to run an agroforestry project in western Kenya. Anna was well suited to this task since she had done extensive research on the uses and propagation of indigenous and naturalized trees and was currently managing a pilot project with the Mazingira Institute[3] and CARE to identify useful species and agroforestry interventions in five agroecological zones in Kenya. CARE had a long history of working with low income rural people to improve their household production and welfare through advancements such as water projects, primary health care, and the development of fuel-conserving wood stoves. Like the government and many organizations in Kenya, they were very concerned with the increasing deforestation—much of it due to the need for fuel, either directly gathered as fuelwood or processed into charcoal.

"That's wonderful news, Anna. This will give us a chance to learn more about doing diagnosis with groups," said David. "I would be glad to help and let you know what we've been learning lately at ICRAF about this."

"Let me give you some background," said Anna. "As you know, there was a terrific response to the president's tree-planting campaign. As a result, the Kenya Forest Department has begun to modify its emphasis on plantation management for timber production and is developing a rural afforestation extension scheme. However, it does not yet have the capacity in extension or seed production to meet farmers' needs. Up to now, they have relied on nongovernment organizations like CARE to propagate and distribute seeds to the groups with which they work. But this has been on a small scale. Now, the Forest Department and CARE want to develop a district-wide scheme, and the Forest Department wants a model for their own rural extension service. CARE is interested in the provision of fuelwood for subsistence level farmers, something which would benefit farmers as well as slow local deforestation. The overall objective is to improve rural welfare in Siaya District through tree planting. To do this, the project goals are to learn what species and what planting arrangements or configurations are suitable for different environments in Siaya, to produce

KENYA	
Area	584,000 km^2; 17% classified as medium or high potential for agriculture.
Population	15,327,000 (1979); growth rate 3.4%; rural population 87.6%.
Income	GDP/capita: Kenya shillings 2,800 (1980). Sources: tourism. Exports: coffee, tea, sisal, pyrethrum.
Ecological Zones	Varied. Coastal belt bordering Indian Ocean, central Highlands, northeastern desert and semidesert, southwestern lakeshore.
Elevation	Varies from sea level to 5,199 m.
Rainfall	Variable by district.
Currency	Kenya shilling (Ksh). Ksh 20 = U.S. $ 1 (1985).

SIAYA DISTRICT	
Area	2,000 km^2 centered on equator.
Population	474,516. Density ranges from 232 km^2 in Ukwala (north) to 143 km in Bondo (south).
Income	North: farming and remittances from off-farm labor. South: fishing, livestock, and farming.
Topography	Generally flat and undulating interrupted by scattered ranges of hills. Two main rivers, Yala and Nzoia.
Rainfall	800 mm on shores of Lake Victoria to 1800 mm in north. Patterns: long rains—March to June (sustained). short rains—August to November (short burst).
Elevation	1,140 m at lake shore to 1,440 m in hills.
Temperature	North: cooler, two-crop system. South: one crop.
Soils	Extremely variable; widespread low fertility and poor drainage. Lake shore: heavy, poorly drained clays (Blackcotton or vertisols); Central south: sandy soils; North: well-drained red loams.

more seeds and seedlings, and to train personnel for working with farmers. Parallel to this, CARE will be introducing those great new cookstoves which are so efficient."

The telephone rang and Anna picked up the receiver. As she talked to her caller, David thought about how rapidly agroforestry had become a popular idea in agricultural development as a potential solution to rural development needs in Africa. David liked to think of it as the domestication of trees, that is, finding useful trees and developing ways in which they become an explicit, planned part of a farming system. Trees have many useful outputs such as fruit, timber, fuelwood, and fodder, and they provide services such as fences, shade, windbreaks, and soil fertility (see Table 7-1).

Agroforestry includes all of the practices that involve a close associa-

Table 7-1

Benefits of Agroforestry Systems

Jobs and Incomes	Household and Farm Use	Environmental Effects
Fuelwood and charcoal	Fuelwood and charcoal	Erosion control
Poles and logs	Building poles	Soil fertility
Gums, resins, and oils	Fodder and forage	Flood and landslide prevention
Commercial food products	Fruit, nuts, and honey	Water availability
Pulpwood	Agricultural uses:	Shade, protection from wind and rain
Sawmilling, carpentry, and handicrafts	Mulch	
Medicines	Soil fertility	
Mushrooms	Shade for animals and crops	
Crafts, utensils	Fencing	
Wildlife, leaves	Thatch	
Tourism	Weaving materials	
	Crafts, utensils	
	Medicines	
	Ornamental	
	Food and spices	

Source: Adapted from Food and Agricultural Organization of the United Nations (FAO), *Forests, Trees and People,* Forestry Topics Report no. 2 (n.d.), 7.

tion of trees or shrubs with crops, animals, and/or pasture. The association may be ecological or economic and may involve a combination in the same place at the same or different times in sequence. Simply put, agroforestry technology consists of three elements: trees, crops, and livestock (the components), location and arrangement, and management. Agroforestry research focuses on the interaction between trees, crops, and livestock of different species. It asks the questions: what trees, crops, and animals, what arrangements, and what kind of management are most beneficial to farmers and herders and fit within their farming and livestock production systems?

Components, the species and varieties of trees and associated crops, differ in their functions or outputs and in their response to different physical environments. They also respond differently to management (How fast or how thickly do they grow? What biomass is produced?), and their effect on their immediate surroundings can range from complementary (e.g. increased soil fertility) to competition (e.g. too much shade) with other plants or animals. Components for recommended agroforestry technologies are chosen for their adaptability to soil and climatic conditions, the desired outputs, desired growth characteristics, and their response to plant management (Scherr 1988).

Multipurpose trees have received special attention in agroforestry research. For instance, some species of trees can be used as living fences, creating an impermeable barrier that protects the homestead or croplands,

and, depending on management, they can be a source of poles or fodder. Other species can be alley cropped (in hedgerows between rows of planted annual crops), with several beneficial outputs. For example, alley cropping can enhance soil fertility through planting nitrogen-fixing trees, which add nitrogen directly to the root zone of nearby crops, or through mulching with harvested leaves on the soil surface. In some species, the leaves can be used for fodder for animals. *Leucaena leucocephala* is a multipurpose tree which has frequently been recommended for alley cropping because of its fast growth and many products. Beneficial use of multipurpose species requires an understanding of what arrangement and management practices will result in preferred outcomes.

Arrangement refers to how trees are planted—location, spacing, or density, orientation to the sun or wind, relationship to other physical elements of the landscape or to associated crops. Arrangement is important in terms of multipurpose trees. For instance, if the objective is fuelwood, but the leaves are palatable, the trees must be planted where neither domestic nor wild animals can get to them.

Management refers to when and how a tree is pruned or harvested. It may differ with the same species for various desired outcomes. For instance, trees used for fuelwood or fodder are regularly cut for small amounts of palatable or easily burned biomass; if used for poles, cutting will be less frequent. Trees used in alley cropping must not compete with crops for sun and therefore might be pruned to reduce the density of the canopy or coppiced (main stem cut) regularly so there is hardly any canopy during the cropping season.

Thus agroforestry research is both biological/technical and socioeconomic, reflecting the need to understand how trees fit into existing farming systems. Biological research involves exploring the technical parameters of different species—requirements for their growth (soil, water, temperature, spacing, etc.), outcomes of different management, their uses or products, and their effect on their immediate surroundings in terms of complementing or competing with other plants or animals. Such research has involved on-station and on-farm trials. Research on alley cropping has included trials between and within row planting densities, different species combinations, and management for different uses such as mulch or fodder. Measurements are taken of the yields of both crop and trees.

Because of the potential in agroforestry for different outcomes, a central issue for socioeconomic research is an understanding of what products or services farmers want from trees. Other factors affecting the acceptability of agroforestry technologies are questions of land and tree tenure or access rights and the availability of labor for optimum management. In some environments, the benefits of alley cropping have been reduced or negated by shade on crops because farmers did not have time to prune or coppice the trees.

David thought about the methodology, Diagnosis and Design (D and D), which ICRAF was developing in order to understand the farming system and to identify promising interventions. D and D took a problem-solving approach, usually focused on the individual farm as the management unit and on individual heads of household as farm managers. D and D was designed for high-level research teams to carry out under time constraints, and it usually involved a small sample chosen by the researchers. The purpose was to gain general descriptive information about the farming system: the typical division of labor, ownership and interests; the main problems faced by farm households and those amenable to agroforestry solutions (at least in part); and a feel for the general expression of these problems at the farm level. Such a diagnosis provided the basis for recommending experimentation with specific agroforestry interventions. The method is iterative, with constant feedback from trials into revised diagnosis and design of new agroforestry practices and/or new trials. David was eager to see this methodology used in a more extension-oriented setting.

As Anna put down the phone, David spoke up, "Tell me what you have been learning in the Mazingira project about working with groups."

Anna answered thoughtfully. "Well, as you know, we originally set up new groups with the idea that they would start nurseries and together have a demonstration plot. We were trying a number of interventions with both indigenous and exotic species. Alley cropping and border plantings with fast-growing, multipurpose trees were the most common. We are trying anything we can get which is known to provide fuelwood and not harm crops. *Grevillea robusta*, *Cassia siamea*, and *Leucaena* are most common, but we are trying many more. Now in each nursery, many different varieties are being grown and we are planting the best seedlings with farmers' crops. But there wasn't much sustained interest. The community plots really didn't go. Instead we are now working with individual farmers. Our field workers are walking with them over their land, developing maps, and then designing trials which fit each farm. We have about eighteen trials going now. This fine-tuning of farmers' own agroforestry systems to accomplish their own objectives within their own constraints is attracting much more interest, and we are learning more about the potentials and constraints of agroforestry. We've been monitoring them regularly and have a pretty good list of what species grow best in each zone. We've continued looking at both indigenous and exotic species and are beginning to get some ideas about which new (noncustomary) species may be substituted for known species, but provide better benefits through faster growth, better versatility, or less competition with crops."

David looked up from his notes. "That's interesting about the groups. As you know, most of our research has been focused on individual farms. I have a colleague who is looking at land use problems on a larger scale, particularly soil erosion. She began working with women's groups in

Kathama, in Machakos, to see to what extent they could help with gully reclamation. She found that they were organized mainly to help each other in labor exchange; that those who join do so because it is helpful to them individually. She also said not everyone can join because of the time requirements—poorer women with small children just don't have the time. There are a few men in those groups too. Since acquiring fuelwood and fodder had been identified as problems in that area, she thought group members would be interested in planting fuel and fodder trees in gullies. However, groups were more interested in starting nurseries for tree seedlings to plant on their own farms than in gully reclamation. Still, the nurseries seem to be working out well."

Anna leaned forward. "We have not yet done group interviews, but are planning to at the end of this season, evaluating the experimental plots. We have found that fast-growing legumes, such as *Leucaena*, have enormous appeal to farmers because of their fast growth and what they have been told about nitrogen-fixation. *Leucaena* does grow fast, but so far no plantings have been as bushy and fast growing as the ones we've been told about from the Nigerian experiments. *Grevillea* is also very popular since it produces poles without interfering with crops. Indigenous trees are not very popular, in large part because they are not new and farmers see little reason to plant them: 'They grow by themselves.'"

David nodded, "By meeting with the groups and with individual members, Mary has learned a lot about different niches for the planting and use of trees. Apparently, for fuelwood and fodder there is liberal access to trees in such places as public and semipublic grazing lands and along roadsides. Even on private lands, nonowners have some access rights. This is often the main source for poorer, often female-headed households. This was new information to the researchers carrying out trials with individual farmers. She also told me another story about this area. Three of the men farmers doing trials were raising their own seedlings, but women in their households were collecting and transporting the water. During the drought, they put their feet down and refused to transport water for seedlings from the only water source which was over two kilometers away."

"Hmm. Water is always a problem," Anna replied. "I am undecided about whether to begin with groups which already have nurseries, or to start new ones. The Mazingira groups were mixed, but most of our farm trials have been with men farmers. We found it extremely difficult to get information about fuelwood availability. The field officers and I have talked about this a lot and now are making a special effort to ask women about fuelwood—and we are getting some answers. Men clearly weren't interested. Now if you ask them about timber, or poles...

"David, you could be of great help," Anna continued. "CARE and the Forest Department want this to start soon and I am still working on the plan. I will need some introductory materials on agroforestry to use in

training fieldworkers since very few people know what has been developed so far. Could you prepare something about the uses of trees and tree products, the characteristics associated with their use, their management, and some recommended species? It should be of species which have inherent potential for fuelwood, for which seed is available, and for which there is information on propagation and establishment. In order to bring something to the groups right at the beginning, we do want to bring five or six of the most promising species—best bets. But over the long run we don't expect to limit ourselves to those. Because they are already out there, let's include the timber trees. I'll give you what we have from Mazingira. I also would like something which describes the various arrangements or configurations which seem useful on small farms."

David's eyes lit up as he nodded again. "I'd be glad to. I can bring something in next week [Appendices 7-A and 7-B]. But you still haven't told me, how is your planning going?"

Anna grimaced. "Right now I have more questions than answers. We are committed to working with groups, but what kinds of groups shall we work with? What are we going to provide to groups in terms of materials? In terms of technical assistance? What can we offer in terms of advice? There seems to be a strong interest in nurseries in the district, but they mostly grow timber trees—eucalyptus and cypress (*Cupressus lusitanica*), which is the only seed they get from the Forest Department. Also, citrus is being promoted by the Ministry of Agriculture and some men are growing it in orchards. Will they be interested in other kinds of trees? Or in planting arrangements other than wood lots? How can we interest people? How can we make sure women's access to fuelwood is improved? Whom should we use for our field officers? What should be included in their training? One problem we are having in Mazingira is that both farmers and field staff focus on nurseries and tree species and do not think much about arrangements and how different configurations fit with objectives of different groups in the community."

"We had the opposite experience at Kathama," remarked David. "The research with individual farmers focused on the demonstration and refinement of a very specific arrangement, alley cropping *Leucaena* or *Cassia* with maize and pigeon peas. The farmers experienced a restricted choice between species and a lack of experience with propagation. In fact plant propagation and establishment became major problems for ICRAF researchers as well. Because of the difficulty of getting good seedlings and plant establishment, there has been only limited progress on their alley cropping experiments. The farmers have now taken a detour into nursery activities in order to gain more skill and experience with raising and planting a variety of species. Most farmers are used to trees in forests as a source of free goods. But conditions are changing and there is a need for more know-how on plant propagation and management."

"It is important to get trees into the ground," Anna observed, "but it is more important to make sure that the varieties chosen and the arrangements are truly beneficial and don't waste people's time or have negative effects on their crops. The challenge of this plan is to continue to experiment based on diagnosis at the local level. I know we don't have a proven package. On the Mazingira project we have learned that there is a very wide range of problems, needs, farm configurations, levels of interest and resource commitments, etc., among households. Extension must be tailored to needs of specific areas and household types. So we need to do research as well as extension. The Kenya Forestry Research Institute (KEFRI)[4] has agreed to carry out trials."

"What you learn there could be useful to ICRAF as well," David declared. "We are finding at Kathama that some farmers, the men doing trials and some of the women from the groups, are taking some of the species we've introduced and are planting them differently, or taking their own species and planting them in our recommended patterns. Some of their experiments are quite interesting. For instance, the original plan called for the classic alley cropping recommendation of using *Leucaena* and *Cassia* for mulch. Instead, they used biomass from fencerows and dispersed trees and put it in cow pens, a sort of precomposting, before putting it on cropland. In cropland, they planted fruit trees or used the multipurpose trees for fodder rather than mulch. In general, women wanted fruit and fodder trees in their nurseries. Alley cropping as it was originally set up in our experiments has nearly disappeared."

"David, do women plant trees in Kathama? I have heard that only men plant trees in Siaya, but we haven't found that elsewhere."

"Women do plant trees in Kathama," David replied, "although it was traditionally a few men who started nurseries and learned horticultural techniques. The recent project activity has made this knowledge available to most women in the community and they use it. However, there was no strong taboo against tree planting by women. We worked with individual farms and most were headed by men, but a few were actually run by women whose husbands were away on wage employment. They usually needed to consult with their husbands about whether and where to plant any introduced trees. Now in Kakamega, just northeast of Siaya, there do seem to be such strong beliefs, but some species which grow low and bushy such as *Sesbania sesban* are considered 'women's shrubs' and women harvest them regularly. The real resistance is to women planting commercially valuable timber or fruit trees. Well, I must go. I will think about an experimental program. Let's talk next week. Good luck with finishing the plan."

After David left, Anna reviewed the information she had on Siaya District. and the reasons that CARE and the Forest Department had picked Siaya. The district had a high energy demand and the potential for serious

deforestation. Farmers were seeking assistance in tree development, and the district forest officer had demonstrated great enthusiasm for decentralizing seedling production to small-scale nurseries, within closer reach of more farmers. Here there was momentum to build upon. Finally, there were many local nongovernment organizations and community groups, but the district was not overly full with assistance from other donor agencies.

Siaya presented a wide range of agroecological conditions, which constituted both an opportunity and a challenge to the agroforestry project. Soils were extremely variable, with widespread problems of poor fertility and inadequate drainage. The district's complex mosaic of landforms, soils, and climate was traversed by two main rivers (the Yala and the Nzoia) and numerous small streams. Together with the Yala Swamp and over one hundred kilometers of lakeshore, these features constituted one of the great resources of the district. The availability of water from rivers, swamps, or lakeshore could be a major advantage in tree planting, although waterlogging of soils might also limit tree planting and cropping activities in farmlands near water.

The natural vegetation in this landscape ranged from remnants of tropical rainforest in the extreme northeast to riverine forests, swamps, and dry acacia woodland in the south. This represented a large pool of local tree and shrub species to choose from, although little was known about most of them in forestry circles. Moreover, many of these species were disappearing, since they could not reproduce naturally under current conditions. Most of the trees in Siaya District were scattered as isolated individuals or clumps in grazing land, cropland, and homesteads. Both natural forest and swamps were under heavy pressure from harvesting of timber and papyrus respectively, as well as a strong tendency toward conversion to cropland. There was in fact a clear case for growing trees on farms in most parts of the district, across all of the ecological zones.

The higher potential, cooler and wetter zones in the north had two cropping seasons and could produce crops such as coffee, while in the south farmers struggled to raise a single crop of sorghum and millet, with perhaps a little cotton for cash. While residents of northern Siaya relied almost exclusively on farming and remittances from absentee men employed in cities and tea and sugar estates, the people in the south mixed farming with fishing and/or livestock production as major activities.

One of the most striking differences between the northern and southern extremes was the density of population, intensity of land use, and size of landholdings. In the north most of the area was occupied by cropland plots of one or two hectares, separated by hedges and occasional pastures. Trees were found on fencelines, in home compounds, and along stream banks, with a few scattered in croplands. In the drier south, cropland plots of one to five hectares were scattered within the large tracts of pasture, fallow, and occasional patches of dry woodland. Aside from the

woodlands, trees were also scattered throughout the grazing land, were fairly concentrated in home compounds, and appeared as isolated or irregularly dispersed individuals in cropland. According to George, the district forest officer, the scattered trees in croplands or fallowed areas were either left after bush clearing and tolerated for their by-products, or resulted from spontaneous regeneration.

There were very few free trees left in the north except for roadside shrubs which were heavily used by women for stickwood and fodder. Timber, poles, craft wood, and even high quality fuelwood were all commercialized due to the relative scarcity of large trees or preferred species in the landscape. Large, old multipurpose trees which used to provide abundant pods for fodder were being cleared for a single purpose, charcoal. Planted cypress and eucalyptus were common in small lots and on property boundaries. In the south, especially in the lakeshore communities, the demand for fuelwood to smoke the commercial catch, Nile perch, placed heavy pressure on the same land and trees which supplied the fodder requirement for livestock (cattle, goats, sheep). These open lands also constituted the frontier for expansion of cropland. While there were still more free trees left in the south, the environmental conditions were much harsher, so the deforestation would cause more serious damage to soil and water resources and it would be more difficult to grow new trees. (The traditional agroforestry practices which Anna observed are summarized in Appendix 7-C.)

In Siaya District, land was adjudicated and registered, usually to the male head of household.[5] Almost all land was privatized and fenced in the north except for hilltops and swamps owned by county councils. Some clan elders also held private grazing lands or water access points which were used by other clan members. By contrast most of the land in the south, except for cropland, was not fenced and was open to shared use for grazing and gathering, even if it was officially private property. Cattle, sheep, and goats also wandered freely through the landscape outside of the cropping season, which was a major constraint to tree planting.

Because the Forest Department was interested in what could be learned about extension from this project, Anna had interviewed people in each of the government extension services serving rural areas to find out what their field officers did, what training they had, and whether there were women extension officers. The Forest Department and rural afforestation extension workers had two years postsecondary education and were familiar with timber species, but had little or no training in agriculture or agroforestry. There were no women in the Forest Department extension service. The agriculture extension staff included both men and women. They had two to three years of postsecondary training, all in agriculture, with a little training in communication skills. The extension workers of the Home Economics Division within the Ministry of Agriculture, all women,

also had two or three years postsecondary training, with at least half of their program in agriculture. Community development workers from the Division of Social Services were also all women and had been trained to the B.A. level. They had little formal training in agriculture and none in forestry.

On an early field trip, Anna had been taken around by George, the district forest officer, to get a feel for the differences in agroecological zones and some of the nurseries already established. According to the forest officer and other people she met, there were basically four types of groups with which CARE might work. Some groups were officially organized and linked with schools, churches, or chiefs; there were also numerous women's groups that were registered with the government but otherwise unaffiliated. All the women's groups had a few male members and some were fifty-fifty. All the groups were Luo, the local ethnic group, and were principally clan based. The four types of groups to be considered were the following:

1. Chief's or subchief's nursery groups. Such nurseries were set up after the president had urged chiefs to make trees available for planting. They were assisted directly by the Forest Department's technicians with seed, tools, and advice. Farmers worked in the nurseries, often with the understanding that they would be paid later by the government in cash as well as in seedlings. In practice, payment most often was not forthcoming, and apathy was beginning to set in.

2. Church-based women's group nurseries. Such groups may or may not have been assisted by the larger membership of their churches. It was hoped that assistance to such groups would have a spread effect to the larger community through the church.

3. Nonaffiliated local women's groups. The Kenya Government Division of Social Services had indicated that in Siaya District there were a large number of women's groups struggling, not too successfully, with income-generating projects which could use some help. The district forest officer was aware of many such groups engaged in development activities, as some had applied to the Forest Department for assistance.

4. Primary schools. The District Forest Department stated that many schools had small-scale tree nurseries and many had applied for assistance.

Anna asked her secretary to hold all calls. She would take the rest of the afternoon to work on a plan for the project that would achieve CARE's objectives to help with deforestation, to develop a model which could be used for the Forest Department's extension service, to incorporate research into the extension process, and to identify and provide assistance for the best designs and species for different uses.

STUDY QUESTIONS

1. What are the ways in which women's and men's roles and preferences are likely to influence the introduction of agroforestry practices or species?

2. How can the proposed project be designed to encourage access for or benefits to women?

3. What is an appropriate job description for extension field staff? What criteria should be used in choosing staff? What should be included in training?

NOTES

1. The International Council on Research in Agroforestry (ICRAF) was established to undertake research on agroforestry practices and on species which could be incorporated into farming systems. For one year it ran a Kenya Agroforestry Tree Seed Project to identify and obtain tree seed appropriate for use in agroforestry projects designed by ICRAF with collaborating Kenyan institutions.

2. CARE International in Kenya (CARE Kenya) is a nongovernment organization which provides assistance to community development. Previous to the Siaya project, CARE Kenya provided financial assistance and project personnel to the ICRAF-sponsored Kenya Agroforestry Tree Seed Project and the Mazingira Institute's Agroforestry Plots for Rural Kenya Project. Other CARE activities in ten districts in Kenya are improvements in water supply, women's income-generating projects, primary school assistance, and assistance to youth polytechnic institutes.

3. The Mazingira Project was a joint project of the Mazingira Institute (a private consulting group which focuses on social research aimed at low income populations), CARE Kenya, the Mennonite Central Committee, and ICRAF. It was intended to examine the potential for promoting agroforestry land-use practices among small holder farmers. This was to be done through collaboration between local, nongovernment organizations and external nongovernment advisory organizations. It was the first effort to have the scientists, ICRAF, provide technical assistance to community groups.

4. When the CARE project began, agricultural and forestry research were both done under the auspices of the Kenya Agricultural Research Institute (KARI). This was later split into two institutions with forestry and agroforestry included in the scope of work of KEFRI. We have therefore used KEFRI throughout the text.

5. Since the late 1950s, much of the land in Kenya which was originally held communally has been measured, adjudicated, and registered to individuals as private property. The replacement of traditional communal property rights by private ownership has been accompanied by an erosion of the traditional responsibilities and protections of men and women. Women, particularly those widowed, divorced, or less favored wives, are especially vulnerable, since the absence of a husband or a husband's disfavor is not balanced by an enforcement of traditional rights.

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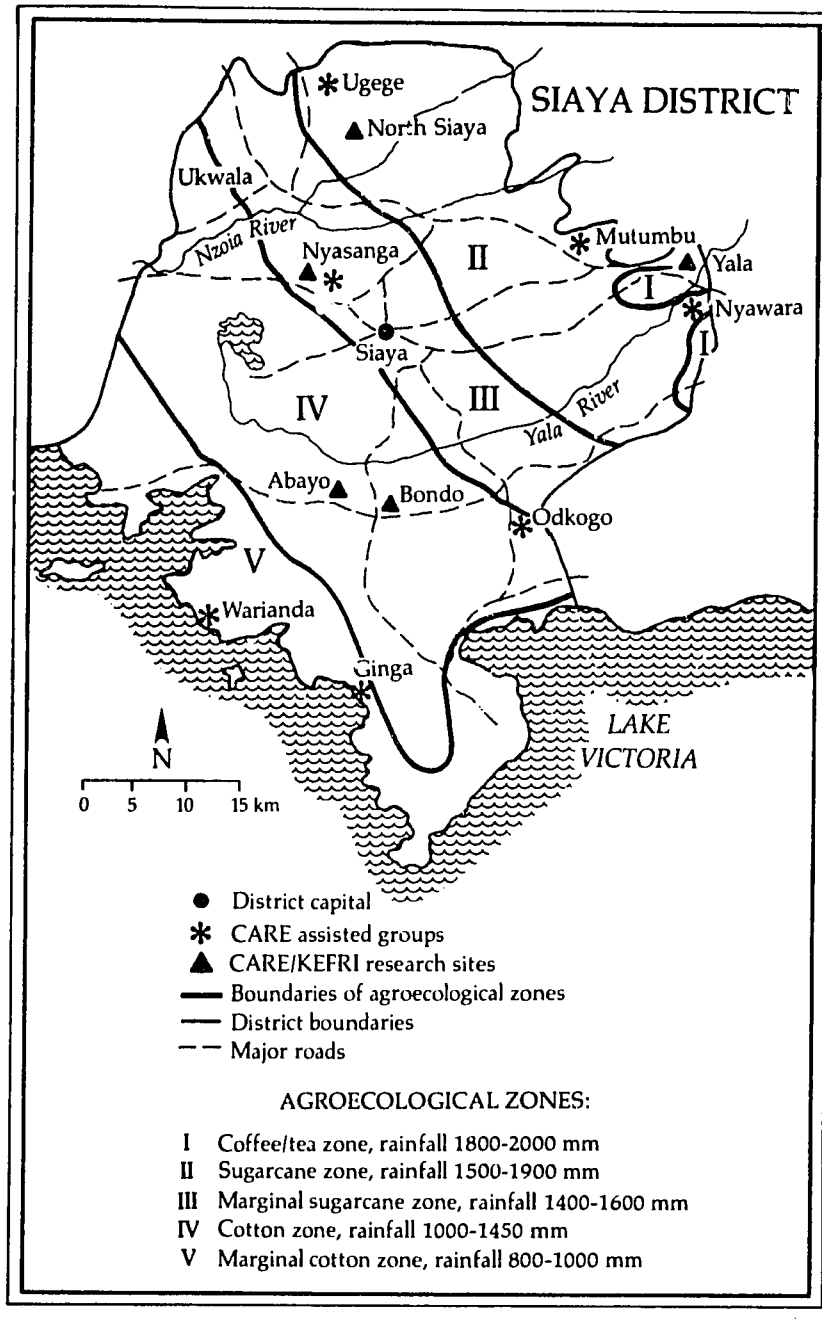
Figure 7-2
Map of Siaya District Showing
Agroecological Zones and CARE Assisted Groups



Kenya: Part 2
The First Nine Months

David sat in the shade of the *Albizia coriara* tree under which people had gathered for discussion for many years. Its extensive leafy branches made a cool retreat from the hot sun. In front of him was the Nyasanga group's community nursery. At the moment five women, whose shift it was, were bringing water from the nearby stream and watering each seedling. Others were pricking out emerging plants from pots where more than one seed had germinated and were planting them in empty pots. Later in the afternoon, the CARE field officers would conduct a meeting with all the members of the group. The practice of arranging meetings to coincide with regular work days had resulted in good attendance of working members. As David rested he thought about how the project had started and how far it had come since his conversation with Anna nine months previously. He was now the project manager, and four field officers had been trained. Three months ago, nine groups began growing CARE seeds, sometimes in the corner of a nursery devoted primarily to timber species, and they would soon be planting out seedlings.

David was particularly pleased with how well the field officers were working with community groups. Mindful of the need to create a model for the regular Forest Department extension service, Anna had decided to experiment a bit with what made a good extension officer and what minimum education level was necessary. She had interviewed a number of people and had selected those who showed leadership skills and who had a variety of ethnic and educational backgrounds. James was a government extension agent who had worked with David in Machakos and had a three-year postsecondary diploma in agriculture. Francis had graduated from a secondary school with an agricultural curriculum and had spent two years doing extension work with a commercial firm. Joyce was a teacher with a home economics diploma. Robert had been a CARE field officer who had worked for a year on the Mazingira project.

The training program had been carefully designed to make the field officers critical analyzers of any kind of development effort. Anna and David wanted the field officers to recognize that they weren't experts, and that they needed to find out what the problems were and be problem solvers. To do that they needed diagnostic and interviewing skills as well as information about agroforestry technologies. The training had begun with hands-on work at the nurseries of the Mazingira project with a par-

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ticular emphasis on record keeping. This included documenting seed collection and supply, seed treatment and management, storage, and when planted. They also tried out and discussed ways to keep groups motivated about their nurseries.

In conjunction with the hands-on experience at the nurseries, the trainees did classroom work on Diagnosis and Design (D and D), carefully taking apart each step of the D and D methodology, and they learned about different components (species and varieties) of agroforestry systems and about their arrangements and management. They learned to do farm sketches and diagnosis and how to follow up after planting. They practiced interviewing with role playing, eventually interviewing the trials farmers of the Mazingira project. To give them experience with groups, David had taken them to Machakos for a week. He had taken special pains to make sure Joyce was treated equally as a full member of the team. He insisted during that week that all the chores of housekeeping be rotated among the team members, leaving them no chance to leave Joyce with all the cooking and cleaning. The group interviews at Kathama were extremely productive. Once the team learned to make special efforts to ask questions of women, they learned a wealth of information about indigenous trees and uses.

For three weeks the group traveled to a number of tree projects, visiting large- and small-scale nongovernment organizations, individual, self-made innovative farmers, and school teachers who were well connected to communities and considered community leaders. This was to help the trainees learn about different project approaches as well as add to their inventory of possible interventions. Finally, they made a field trip to Siaya. Anna had held off on picking groups and had asked the trainees to interview a variety of groups and take part in selecting them. They had spent ten days interviewing local groups within each of the four categories. They were to look for groups which met these criteria: proximity to water sites and to a demonstration site, group provision of building materials to provide shade, secure tenure for site, evidence of group stability, high motivation, and willingness to meet the project's terms of assistance which would include a lot of interviewing. The nine nurseries chosen represented diversity in agroecological zone and group organization. One was a school group and two were chief's groups; all three had begun tree nurseries from which seedlings were sold. Six women's groups were selected—they had come together for various purposes: community gardens, labor exchange, crafts, or cooperative marketing.

Traveling with an expert on indigenous trees, the trainees had spent ten days touring the district, identifying indigenous species and current agroforestry practices. They learned that in Siaya planting was identified with new trees, usually timber species or fruit trees. Indigenous trees were viewed as something already there, to be used or managed.

The final week of training had been on formal communication skills, incorporating concepts of "I'm okay, you're okay."[1] This was done to reinforce the idea that extension in this project would not be top-down. Farmers were to be recognized as knowledgeable about their own practices and as already practicing agroforestry. This was a distinct shift from earlier practice where D and D had been used to learn about farmer circumstances, and that information used to design agroforestry technologies to be brought back to farmers as something new. Training also focused on techniques which would help ensure an equal voice for women and included role playing with each other, pretending to be shy women or outspoken men, or wealthy versus poor farmers. The implementation plan called for working with local groups to accomplish the following:

1. Identify needs for trees in their area (diagnosis).

2. Select appropriate species and general configuration (design).

3. Select with individual farmers good locations and configurations on their farms for planting trees directly (on-farm design).

4. Establish and manage nurseries for raising the selected species.

5. Establish demonstration sites near nurseries.

6. Develop appropriate tree management practices.

7. Monitor and evaluate activities and tree and crop performance, including participant judgement as a basis for modification or redesign.

The seeds given to the nurseries during the first season were chosen on the basis of Mazingira project experience: species that were popular in those project environments and which seemed suitable for the respective zones of Siaya, and species for which seed was available (see Appendix 7-D). The earlier inventory of indigenous species was taken into account. The established nurseries often had received timber and fruit tree species earlier from the Forest Department.

At the beginning of the year, the nurseries were given their materials and the field officers trained them in good nursery practices. The initial package of support consisted of funds for a guard, a wheel barrow, watering cans, a hoe, a rake, polybags for seedlings, and tree seed. Emphasis was on self-management of the nurseries rather than leaving them to a paid caretaker. Working through groups seemed to have been a good choice, since there were many well-organized groups in Siaya and there was not a

tradition of raising seedlings on individual farms. Soon the first seedlings would be ready for planting out and extension team members would begin making regular visits to members of these groups to assist in on-farm design and management. David estimated that most nurseries would have one thousand to two thousand CARE seedlings for planting out.

The plan also called for trials to evaluate introduced species under different agroforestry arrangements and under the ecological conditions in the district. A KEFRI field officer had been assigned to set up the trials at five research and demonstration sites associated with nurseries. David would be meeting with him the following week to go over the designs. Close monitoring of farmer practice was also called for. The project would change as more information was learned about the possible roles of agroforestry for small farmers in Siaya.

The nine nurseries had been established as concentration areas within each zone. The results of the trials and the D and D and extension done with these groups would be the basis of the technical packages provided to nearby groups.

David and Mary (his colleague from ICRAF) and the field officers were conducting interviews with each of the nine groups so that the project staff (and ICRAF) could develop a general procedure for diagnostic interviews with community groups. In previous diagnostic work by ICRAF and CARE, community interviews had come much later in the process. They hoped to get a good description of the existing system and how it worked and to identify land use problems that might be solved by agroforestry interventions. This format would allow the team to poll group members about types of trees and planting niches already of interest to them, and it would spur discussion among the clients themselves about some of the issues raised.

David read over his notes from the seven groups that had been interviewed so far (Appendices 7-E and 7-F). Several things were already evident: men and women had different knowledge, different ownership and access, different tasks, and different uses for trees. Men were interested in fodder and building poles, especially for sale; women in fuelwood; both in soil improvement. Some groups, particularly in the north, high potential area, were primarily interested in nurseries for income generation; that is, in selling popular seedlings such as *Eucalyptus* or *Citrus* for cash. Near the lakeshore there was a high demand for fuelwood for smoking fish. People bought fuelwood, or, if they couldn't afford it, used shrubs or *Euphorbia*. Women paid for it with their own money or with money from remittances. Some, but not enough, fuelwood was available on the roadside. In the diagnostic interviews, men were readier to speak up than women. The field officers were able to offset this by directing their questions to women, asking questions about which they would have special knowledge, or by approaching them with questions later when they were alone.

In the discussions and pooling of notes which had followed, the team had noticed that it was ranking, rather than defining, the problems that divided people more sharply. In many cases men and women recognized each other's problems and would mention them if asked specifically, or would accept the others' point if it was raised, but they usually disagreed on the relative importance of some problems and their solution. Overall, both men and women agreed on the need to improve yields, expressing an indirect concern for soil fertility and overall soil condition. At the end of the interview, group members indicated where trees could be planted and what species they would like to plant. The groups often chose the popular forest department species such as *Eucalyptus spp.* and *Cupressus lusitanica,* or the new trees, such as *Leucaenea* and *Gliricidia sepium.* The group interviews had confirmed the active use of a number of indigenous or naturalized trees and a strong interest in fruit trees.

David's notes indicated that the main gender issues to surface were whether women could and would plant trees, whether they could own the trees or use their products (whether the trees were planted by them or not), and which types of trees they would like to plant. During the interview at Ginga, the group members replied almost unanimously that a man (head, son) would plant the trees and would be considered the owner. When the women were questioned further about how this would affect their access to the trees and tree products, the women found this to be a strange question. Mary had recounted to them the experience of some women in a neighboring district who had helped to raise and tend trees planted and owned by their husbands or sons. They were denied access to the trees for coppiced fuelwood, since the men were keeping the trees for building poles, and the species and management practice did not provide much at all in the way of fuelwood by-products. The question therefore was whether these women felt that planting and ownership by men could result in such a situation. An elderly woman leader immediately replied, "One would not cook for such a man," to which first the women and later the men nodded in agreement. One of the elder men said, "That would be just." The team had agreed to let the question rest in the capable hands of the Ginga community without further concern for the moment.

In Nyasanga, where both men and women were farmers but where there were many absentee men and a clear division of responsibilities between men and women when both were present, these differences surfaced in the voting on priority farm needs. After listing all of the problems and needs that might be addressed by agroforestry technologies, the group had voted for their top-ranked choices. While everyone seemed to agree on declining crop yields as the number one problem, some controversy arose over the importance of fodder. The team had noted the apparent disagreement between some group members, and James (the dis-

cussion leader) had continued on to the next item, fuelwood. When nearly all of the women present registered their vote for fuelwood as number two, several men objected, accusing them "... but you promised to vote for fodder." Aside from being pleased that the whole topic of trees had aroused such fervent participation, the team had noted the division of interests, the attempt by the interested men to sway the women's choice, and the women's response, an independent vote. At a later interview in Ugege, the team had found a similar division of interests between women's interest in fuelwood and men's in fodder.

On the basis of the interviews and their own observations of what farmers did, the field team had decided that the most promising approach toward introducing agroforestry practices was to help farmers regularize current practices and do more planting in specific, complementary spaces. For the first season's on-farm planning with individual households, they decided to focus principally on (1) lines of trees, either living fences for protection of crops and fuelwood or boundary markers for poles or fodder and (2) alley cropping for mulch, fuelwood, and soil fertility, using the species available in the nurseries (Appendix 7-G). These packages would be the basis of the trials being conducted by KEFRI to establish the technical specifications appropriate to different zones.

The sharing of work and training as well as ownership of land, trees, and their products was still troubling Mary. She wanted to be sure that the project would introduce agroforestry technologies and would make plans that would be practical for women to manage for their own benefit. The project's approach would also require a better sense of local land and tree rights, both rules and practice, at the household and community level. Between rounds of group interviews, Mary brought up the question of the division of labor, access to resources, and control of resources between men and women.

David had very few answers, but he had just hired a young woman sociology student on vacation from the university. "Achola is from Siaya and she's expressed an interest in more in-depth social research on agroforestry technology development and extension in the district. Let's see if we can arrange for you to meet with her this afternoon. She ought to have some leads for you on these questions."

After Mary explained her interest in women's access to land and trees, Achola thought for a moment. "Under the law, on paper, the men own all the land and all the trees. But let me tell you how it really works: with a mix of traditional rules and changing practices. Most rural people live in extended family compounds, owned and managed by one man, with separate spaces for homes and fields allocated to each of his wives and later to their sons. Eventually some of the sons may move to a new site and build their own compounds while some remain on their father's compound and inherit their own portion of the holding through their

mothers. The exact sequence is a little complicated, but for us the important point is that any married woman or widow on the compound has rights to reside there in her own house, rights of access to a plot of cropland for farming, and rights to gather tree and other wild plant products from her plot or from the main fences, grazing areas, and communal lands subject to her husband's, son's, or father-in-law's permission. The actual products, and particularly the harvested grain from each woman's field, are her own property. She can sell, store, or use them as she wishes. The only thing is, she's responsible for feeding and educating her own children, so it's important to get a surplus if she also wants to sell some for cash to pay primary school fees."

Mary looked puzzled. "Hmmm ... this is hard to picture. How does it look on the ground? Can you sketch a typical farm for me with men's and women's land, trees, and produce?"

"Sure," replied Achola. "Here's a compound with one elder man, his three wives, and two married sons—sons number two and three.The first son does not reside here as he must go to start a new compound elsewhere. The last son, the fourth, will be the one who stays permanently. [See Figure 7-3.] This is one version of current practice, a change from previous tradition. This will give you a general idea."

"That's pretty clear." Mary was relieved that the picture gave her a good visual grasp of spaces where trees could be planted.

But Achola hadn't finished yet. "Now remember that the man owns and allocates the land, so each woman's fields may change in size and location as the elder man or his sons take new wives."

"Whoops..." Mary continued her questioning. "So what happens if a woman plants a citrus tree in her plot and the plot changes after the tree has matured? Who owns the tree?"

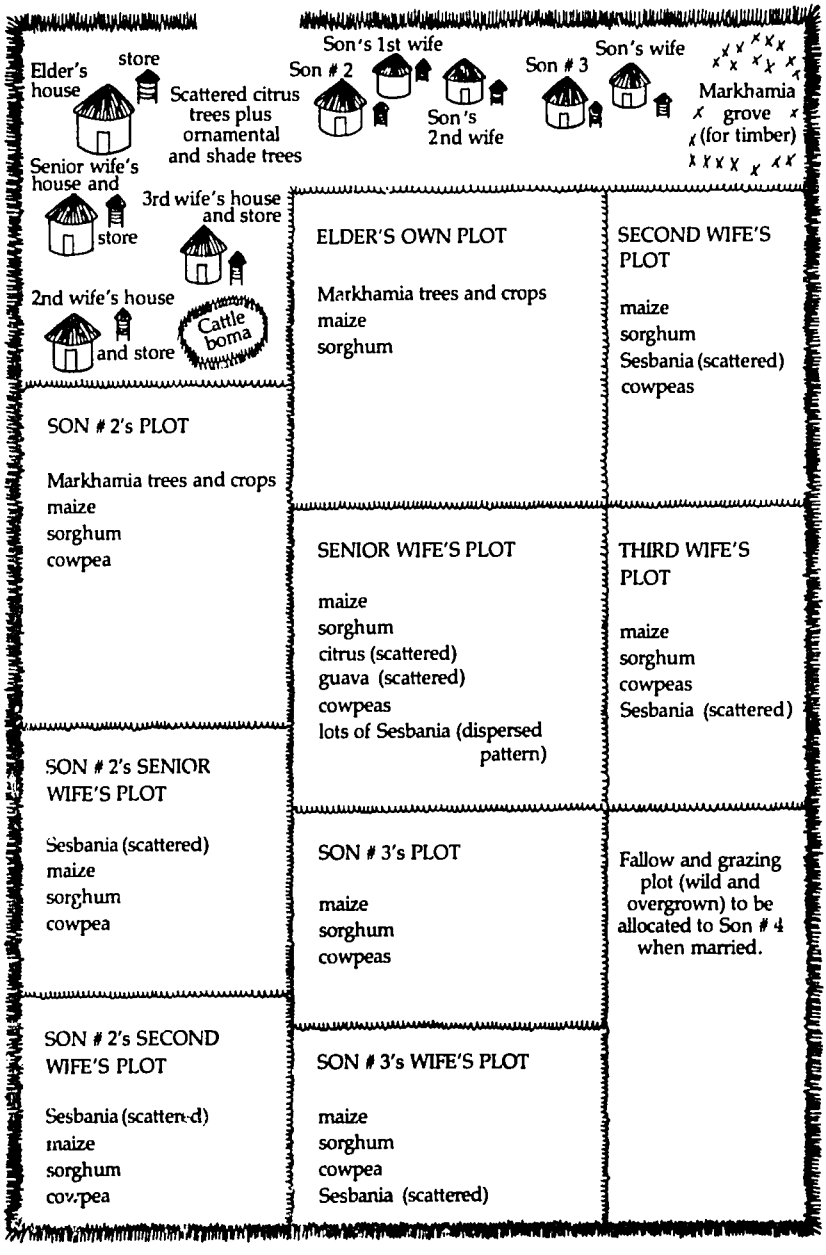
Achola responded quickly. "Mostly women don't plant trees, especially valuable trees for commercial products like coffee, timber, or exotic fruits. Probably her husband or son would plant it. But no matter who plants it, the tree is on the headman's land and it's a permanent thing, and a valuable one at that, so it's the man's property. But don't let that get in the way. The fruit would probably belong to whoever had managed and cared for the tree, if he or she continued to do so. Now if the woman wanted to cut the tree down and sell it for charcoal, that's a different matter; she'd have to ask the man's permission."

"What about some of these small trees in hedgerows? Or shrubs used for fuelwood, mulch or fodder? If a woman were to plant them or to have her sons plant them, would she need permission to cut them? On her cropland? On the boundary of her own plot? On the outside boundaries of the compound? Around her own house?" Mary paused in writing her notes.

"It will vary from one case to another," answered Achola, "but I'll tell you one thing: the men in the household, especially the headmen, are

Figure 7-3

Achola's Sketch of a Typical Farm in Siaya



Legend

Living fence around compound

Internal hedge, usually low, weedy hedges or grass strips

going to have the most to say about where new trees can go and about who can use any existing trees in new ways. They may want to try out anything new on their own plot, which is worked by all of the women in the compound. Or, if they're skeptical about this, they may wish to limit new trees to spaces where there is little risk of interference with crops." Achola paused. "But tell me, Mary, what difference does all this make to the agroforestry project?"

"Yes," said David from the doorway. "How will this help us?"

"Maybe a lot." Mary spoke with conviction. "Ownership or secure access are usually important prerequisites for tree planting on a large scale. There could be two problems in this case: one is that if women don't feel secure enough about control over benefits, they may not plant, except for a few scattered trees here and there. The other possibility is that they do invest lots of time and effort in planting and then lose control of the benefits. This is less likely at the lakeshore where men's and women's work is still complementary. Or maybe the women plan their nursery work with one arrangement in mind and the men have a different idea which isn't compatible with the species already raised and ready to plant.... I'm worried about how the women in the nursery groups get from raising seedlings to having their own trees (or control of their own tree products) on the farm.

"What you've explained, Achola, may be worth a closer look. And I think that the field staff are going to face some tricky situations when they get to planting at the farm level. They'll have to deal with women's spaces (which are pretty limited) or with the nesting of women's plants and women's products into plots, and with planting arrangements under men's control. From what you said about the men's own fields, it sounds like women's control of their own labor and that of others can also be subject to prior demands from the senior men. Widows, wives of headmen versus sons, and senior versus junior wives may all have different constraints and opportunities in terms of planting places, arrangements, and management. And of course many people also now live in single family compounds, and their approach is bound to differ from the more common traditional situation you've just described. Gone are the simple days of interviewing the farmer. These field workers may need to know more about negotiation and less about trees!"

"Okay," said David. "But remember, this project is not only for women. Agroforestry and trees have benefits for both men and women, and what we are concerned with is improving family welfare as well as stopping deforestation. Still, I can see we're going to have a tricky transition from group nurseries to on-farm agroforestry practices, since both the actors and their roles will change. Let's think about what this means for the content and style of our farm level operations. In the meanwhile, let me introduce you both to Grace, a teacher who has done tree-planting projects in schools with both boys and girls."

Mary and Achola explained to Grace the project's concern about how to work directly with women in a situation where women's participation in tree planting might be limited. They had heard from the foresters that Grace herself was quite an active tree planter as were some of the girls in her school.

"It's very true that this taboo exists against women planting trees," Grace said. "You can't ignore it. Some people believe that it will bring bad luck and besides that they consider it to be inappropriate, much as building a house or doing other men's tasks is. But remember that it also used to be considered inappropriate for girls to go to school, or for women to teach school, like me. When I do tree-planting projects, I give the girls an opportunity and an example and I don't push. Lots of girls eventually join in, while others may limit their participation to the nursery work, which does not have this label as a man's job."

Mary wondered if this experience was typical. "But to what extent is the flexibility of some of your girl students due to their age and their level of education?"

Grace answered without hesitation. "Oh, there's no doubt. Age plays a part and so does education. But so does personality and group experience and the changing shape of families. Every woman in this district is probably involved in some activity that wasn't part of her mother's world. My advice is to make this activity available and let some women employees or leaders set an example, without a lot of fanfare. Then stand back and watch: you'll see some women planting trees, and some will find roundabout ways of getting the job done, and some will bring their menfolk into the picture as partners. Just be prepared to work with a whole range of different approaches."

Mary turned to David with a smile. "Well, David, it looks like you've got your work cut out for you. All this real-world complexity is going to demand a lot of creativity and flexibility from you and your field staff."

"And," David replied, "I've got to write a work plan and an activity calendar that give our head office and our field workers something concrete to hold onto. Let's talk about how to design this flexible construction over dinner."

STUDY QUESTIONS

1. What steps were taken by the CARE project to facilitate the inclusion of women in this project?

2. Evaluate the recommended agroforestry practices and species for Mutumbu and/or Ginga. What are the implications for gender?

3. What are your recommendations for the distribution and planting out of seedlings from each nursery?
4. What agroforestry research should be recommended by the project?

NOTE

1. "I'm okay, you're okay" is the key component of Transactional Analysis. Through role playing and other exercises, participants learn to honor their own knowledge and strengths and to acknowledge the knowledge and experience of others. The idea is that differences are just that—differences—and should not be the basis of making judgements which establishes a hierarchy between two parties. As applied to the CARE agroforestry project, farmers were to be seen as equals and collaborators with the field officers. This is distinctly different from the top-down mode often employed by extension personnel.

Appendix 7-A: Agroforestry Practices

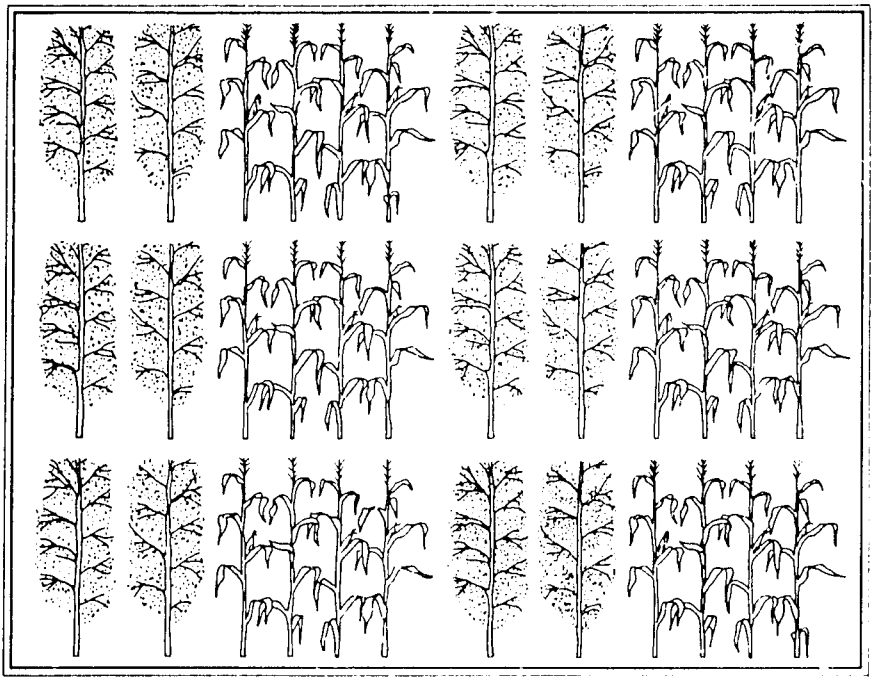
RECOMMENDED AGROFORESTRY ARRANGEMENTS

Alley cropping. Hedgerows of closely spaced trees are planted along the contour at regular intervals (three to six meters). (See Figure 7-A.1.) Nitrogen-fixing trees are selected. Depending on the species, the trees may be a source of fuelwood, fodder, mulch, or poles. When used in alley cropping, trees must be cut so that light is available to the crops either through "coppicing-small"—keeping plants short and bushy—or pruning or pollarding so that the canopy is well above the croplands and the diameter and density are reduced. When used for mulch, the trees are pruned frequently, the leaves and branches are applied as a mulch, and the branches are collected for fuelwood after the bark has decomposed. (See Figure 7-A.2.) There are reported instances in Kenya that one acre of land under alley cropping has produced four thousand kilograms of firewood per year and added forty kilograms of nitrogen to the soil. With some species, nitrogen fixation also occurs through the root nodules.

Living fences. Trees are planted close together to create a density sufficient to create a barrier between areas. They can be used for protecting homestead or cropland from animals, and can be distinguished from boundary marking by the creation of a barrier rather than just marking. Depending on the species, the trees can be a source of fuelwood, mulch, poles, and possibly fodder. Management such as early coppicing or very selective pruning which promotes density is required.

Figure 7-A.1

Alley Cropping with Maize and *Leucaena leucocephala*



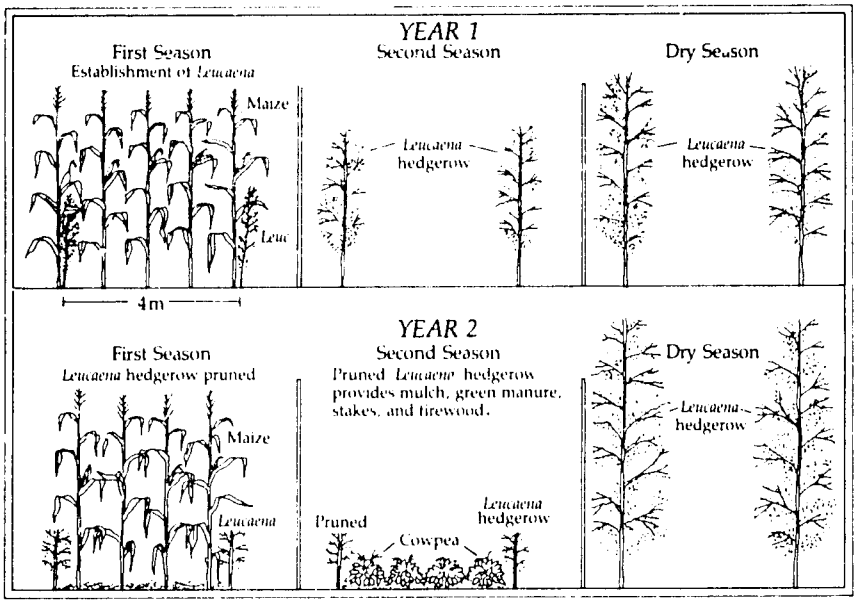
Boundary planting. Trees are planted to mark boundaries and may be, as in a semipublic area, an economic area for planting trees (see Figure 7-A.3). The boundary may serve a combination of functions, such as windbreak, fuelwood production, fruit production, pole production, protection, and demarcation. Spacings vary according to the species used and the specific end-use of the tree. In areas where animals graze freely, browse trees are not desirable in croplands or as fences; where cut-and-carry feeding is the mode, trees which produce fodder may be desirable.

Windbreaks. Large species of trees, often planted in combination with shorter species, are set at right angles to the prevailing winds to direct wind away from plants or the homestead (see Figure 7-A.4).

Home gardens. Plantings in home or school compounds can vary from a few trees for shade or decoration to dense multistory plots of fruits and vegetables. In addition to shade and ornamentation, home compounds may include trees or shrubs for medicines, herbs, and fruit, and they provide a good environment for seedling nurseries. Fruit trees are mostly planted on compounds. For primary schools the fast producing papaya (*Carica papaya)* and passion fruit (*Passiflora edulis*) are recommended. Fruit trees help improve nutritional status. (see Figure 7-A.5.)

Figure 7-A.2

Cropping Sequence Diagram for Establishing *Leucaena leucocephala* Hedgerow for Alley Cropping with Sequentially Cropped Maize and Cowpeas



Source. Adapted from B.T. King, G.F. Wilson and T.L. Lawson. *Alley Cropping: A Stable Alternative to Shifting Cultivation.* Ibadan, Nigeria: International Institute of Tropical Agriculture, 1986.

Woodlots. In addition to commercial species, new or enriched woodlots may include new species such as multipurpose trees, herbaceous crops, or controlled animal grazing.

MANAGEMENT PRACTICES

Cutting the tree at different points in the life cycle or with different frequencies affects the growth and ultimate shape of the tree as well as the potential for harvesting different products. Earlier and more frequent cutting favors leaf production over wood.

Coppicing. Technically, coppicing refers to a tree's response to being cut at the base and continuing to grow many branches which can be used for poles or fuelwood. For instance, some species when cut for timber continue to produce poles. Trees which coppice readily produce more fuelwood or poles and do not need to be replanted as often. As a verb, "coppicing" is also used to describe intentional cutting for just such a response. "Coppicing-small" refers to cutting done early in the tree growth, producing more of a bush and providing leaves and light branches for mulch or

Figure 7-A.3

Boundary Planting of Trees Around a Maize Field

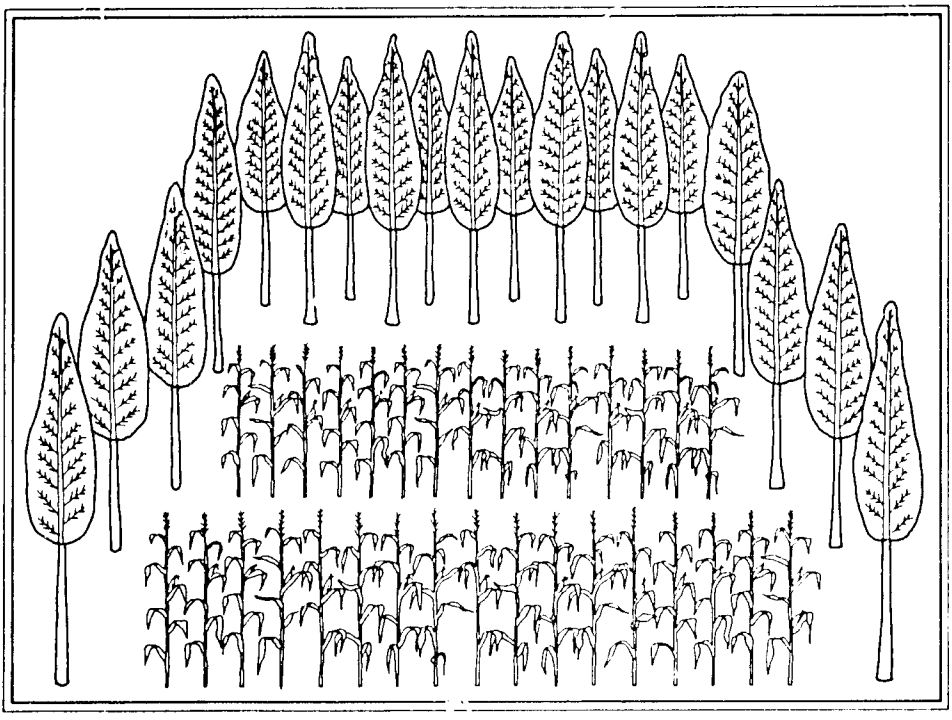


Figure 7-A.4

Windbreak Design

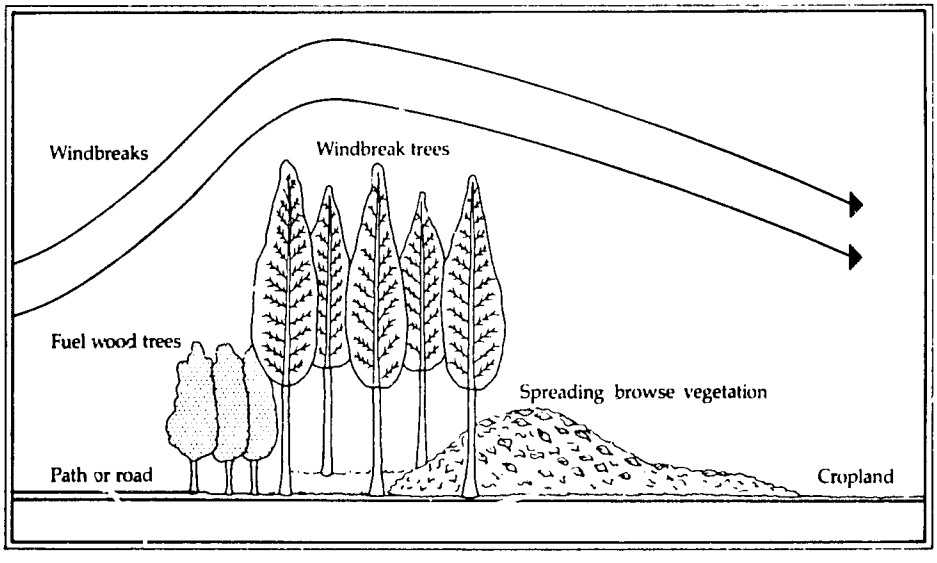


Figure 7-A.5

Schematic Representation of a Home Garden with Tree, Fruit and Vegetable Crops

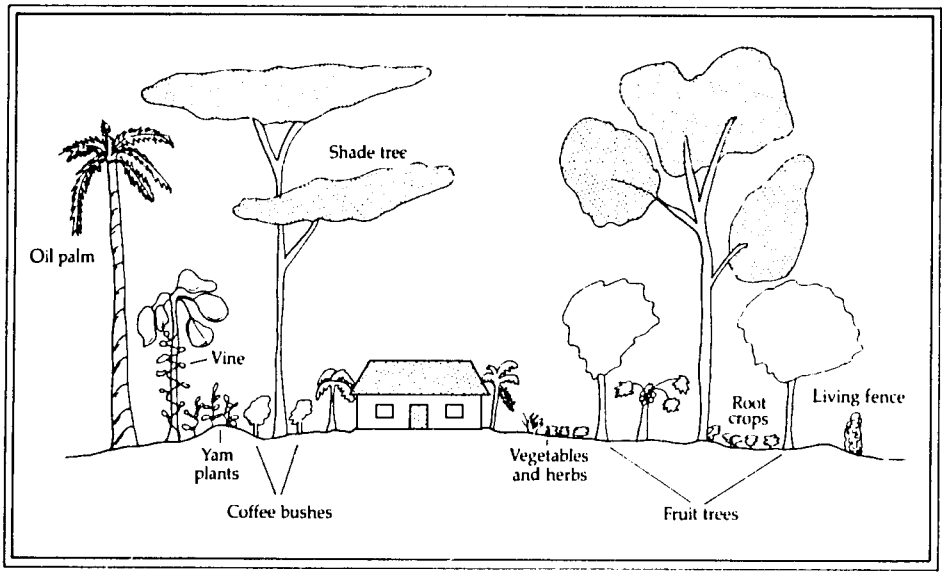
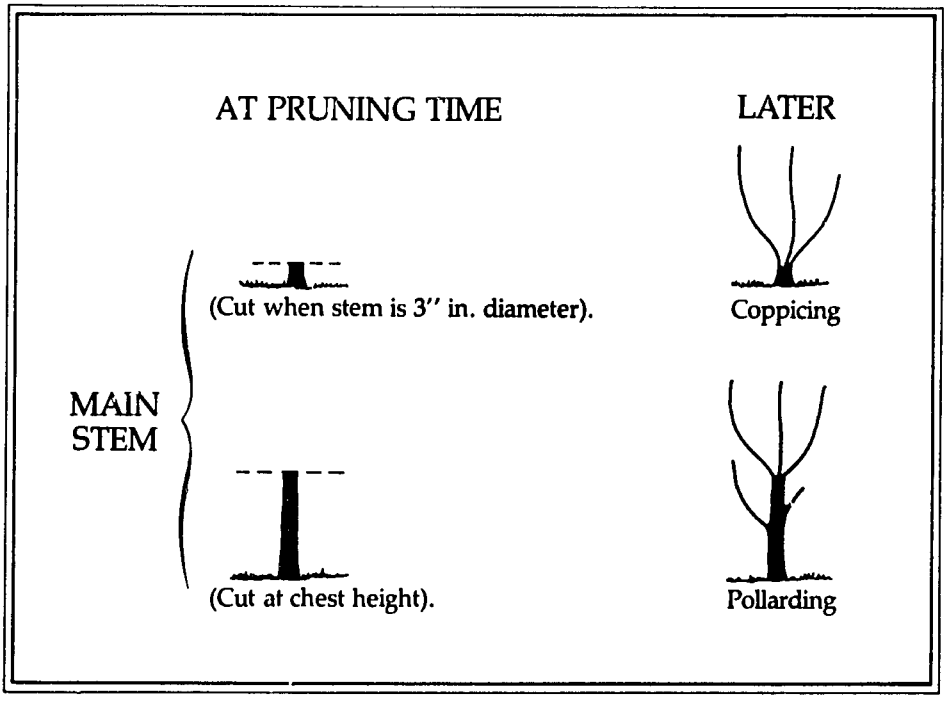


Figure 7-A.6

Pruning the Main Trunk: Coppicing and Pollarding



fodder. "Coppicing-large" refers to the continued production of poles after the main trunk has been harvested. (See Figure 7-A.6.)

Lopping. The side branches of the tree are cut, not the main stem. This technique is often used for collecting fodder for animals.

Pollarding. The tree is cut at chest height or higher and it branches out at that height. This technique is often used in alley cropping to remove the canopy for the growing season, or to create fence posts in fences (in combination with wire or with smaller species). Pollarding of fodder species keeps leaves out of the way of animals, reserving them for cut and carry. (See Figure 7-A.6.)

Pruning. Branches of tree are selectively cut, depending on their purpose. Pruning may be used for harvesting fuelwood, for shaping the main trunk for timber (often a compromise is necessary here), for shaping the growth of fruit trees, or to let in light with alley cropping.

Mulching or composting with tree leaves. Trees may not be present in the cropland, but leaves and twigs are used either as mulch, laid directly on the soil in the cropland, or as compost. In composting, twigs and leaves are combined with manure and/or long grasses; the gradual decomposition leaves a rich, organic fertilizer.

Thinning. Trees planted close together may be selectively cut down or thinned in order to reduce density and to manage the spread of a prolific species.

PLANT PROPAGATION

Plant propagation may be by direct seeding, by grafting cuttings, or by transplanting wildlings or nursery seedlings. Some trees regenerate rapidly after being cut, producing additional harvests and requiring less frequent replanting. Development of seedlings for transplanting requires access to water.

TECHNICAL SPECIFICATIONS FOR AGROFORESTRY TECHNOLOGIES

In designing and experimenting in agroforestry, researchers need to determine the technical specifications for a particular practice. Some of these specifications are known. They are given by farmer preferences—production of straight marketable poles or a planting density sufficient to prevent passage of animals—or must be adapted for local soil and climatic conditions. Other specifications are unknown and are the subject of experimentation with measurement of various kinds of interactions. For example, optimum within-row or between-row planting will vary with location, species of both trees and nearby crops, and likely management practices. What is optimum will depend on what is being considered—a living fence where density is an issue, or alley cropping where competi-

tion (for light) or contribution (to soil fertility) are important effects. The technical specifications of an agroforestry design or experiment include what is known and what is still unknown in the following categories:[1]

1. *Functions or uses*: What will the agroforestry technology achieve for the farmer?
   - Products
   - Services (windbreak, fencing, etc.)
2. *Locations*: For what landscape niche is the technology intended and what are the site characteristics?
   - Space available or desirable
   - Required soil and topographic conditions
   - Access to water
3. *Arrangements*: What plants should be in association? What geometry? What spacing?
   - Number of rows
   - Between-row spacing of like species or in conjunction with crops
   - In-row spacing
   - Proportionality with one or more species (tree or crop)
   - Orientation to sun and wind
4. *Components or species*: What are the criteria for selecting species—Climatic suitability? Products? Growth characteristics? Responses to management?
   - Specifications common to all
   - Specifications for particular uses or functions
   - Combinations of species or tree species and crops
5. *Technology management*: What management of trees and crops will produce desired results?
   - Time and method of establishing trees (including seed acquisition)
   - Desirable frequency of lopping or pruning
   - Desirable form of cutting (coppicing, pollarding, etc.)
   - Harvesting cycle or timing
   - Training of trees to desirable shape
   - Removal
   - Management of associated nonwoody species
   - Specific inputs required—labor, land, soil amendments, polybags, etc.
   - User characteristics—who is likely to use; interest in using

NOTE

1. Sara J. Scherr. 1988. Pilot Survey of Adopted Agroforestry Practices in the CARE Agroforestry Extension Project. Kisumu/Siaya Trip Report. 23–25 November and 30 November–4 December 1987.

Appendix 7-B: Species Available to Group Nurseries: First Season

Zone	Species	Recommended Uses
North	•*Cassia siamea*	Fuelwood, fencing, charcoal
	•*Cupressus lusitanica*	Fuelwood, timber, fencing
	•*Eucalyptus spp.*	Fuelwood, fencing, timber, poles
	•*Gliricidia sepium*	Fuelwood, fodder, charcoal, soil fertility, mulch
	•*Grevillea robusta*	Fuelwood, timber, soil fertility, poles
	•*Leucaena leucocephala*	Fuelwood, fodder, soil fertility, poles
	•*Psidium guayava*	Fruit (guava), fuelwood
South	*Balanites aegyptiaca*	Fuelwood, fodder, timber
	•*Parkinsonia aculeata*	Fuelwood, fodder, fencing, charcoal
	Prosopis chilensis	Fuelwood, fodder, soil fertility, charcoal
Both	*Markhamia lutea*	Fuelwood, fodder, timber
	•*Passiflora edulis*	Fruit (passion fruit)

•Exotics or newly introduced

Appendix 7-C: Traditional Agroforestry Practices in All Zones

Zone	Practices
All	*Markhamia lutea* intercropping with food crops (tolerated for pole/timber value)
	Sesbania sesban intercropping with food crops (tolerated, used for fuel)
	Shade trees in home compounds
	Euphorbia and sisal boundary plantings
North	*Albizia* intercropping with food crops (tolerated for its by-products)
	Eucalyptus/cypress/markhamia wood lots (common, commercial, promoted by Forest Dept.)
	Cypress fencing of home compound
	Home compound gardens with useful trees
South	*Acacia spp.* intercropping with food crops (tolerated for fuelwood, etc.)
	Euphorbia fencing of home compound
	Markhamia intercropping with cotton (tolerated)
	Acacias and other fodder trees in pastureland
	Albizia intercropping with food crops

Source: CARE Kenya. Results of Diagnostic Studies of CARE Project.

Appendix 7-D: Recommended Agroforestry Species and Their Uses: First Season

First Season Species	Uses													Management Practices						Growth Habit			AgroEcological Zone	
	Charcoal	Craftwood	Erosion control	Fencing	Fodder	Food	Fuelwood	Medicine	Mulch	Ornamental	Poles	Shade	Soil fertility	Timber	Coppice, small	Coppice, large	Pollard	Prune	Full tree, renewable	Full tree, single harvest	Fast	Medium	Slow	North	South
Balanites aegyptiaca	●	●			●	●	●	●				●		●				●		●			●		●
Cassia siamea*	●			●			●	●	●	●	●	●		●	●	●		●		●	●			●	●
Cupressus lusitanica*	●			●			●				●		X	●				●		●		●		●	
Eucalyptus spp.*	●		X				●	●			●		X	●		●		●		●	●			●	
Gliricidia sepium*	●	●	●	●	●		●		●	●		●	●	●	●	●	●	●			●			●	
Grevillea robusta*	●			●			●		●	●	●	●		●				●		●		●		●	
Leucaena leucocephala*	●		●		●	●	●		●		●		●		●	●	●	●			●			●	
Parkinsonia aculeata*	●		●	●	●		●			●					●			●	●			●			●
Passiflora edulis*						●												●			●			●	●
Prosopis chilensis*	●			●	●	●	●				●		●	●				●	●			●			●
Psidium guayava*	●					●	●											●	●			●		●	

* Exotic and newly or recently introduced species.
X = Negative effect

Appendix 7-E: Characteristics and Main Problems of CARE Nursery Groups

Group	Mutumbu	Ginga	Nyasanga	Warianda	Odkoga	Ugege	Nyawara
Women	24	22	28	6	8	80	0
Men	2	0	4	5	8	20	4
Nature of Group	Women's	Women's	Women's	Chief's	Women's	Women's	Chief's
Main problems ranked[a]							
Pests[b]	1	—	4	1,3,4	—	3,4,5	2
Striga	1	—	—	—	—	—	3
Soil Fertility	2	—	1	5	2	1	1
Ticks	3	—	—	—	—	—	—
Liverfluke	4	—	—	—	—	—	—
Rainfall	—	1	—	6	1	2	—
Fish	—	2	—	—	—	—	—
Cash	—	3	—	—	3		5
Fuel	—	4	2	—	4	7	4
Fodder	—	5	3	7	5	6	6
Land	—	6	—	—	—	—	—
Seasonal labor	—	—	5	2	—	—	—
Number of species used							
Crops	8	8	10	9	16	15	15
Fruits	11	6	10	6	11	9	1
Fuel	13	6	13	7[c]	8[c]	14	10
Timber	5	3	4	9	6	—	6
Fodder	8	7	7+	14	7	5	—
Handicrafts	2	7	4	6	—	—	—
Medicine	3	2	0	—	—	—	—
Planted on cropland	4	3	2	7	?	2	—

[a]Problems ranking: 1 = most serious, 7 = least serious.
[b]Multiple listings reflect ranking of specific pests.
[c]Includes species used for charcoal production.

Appendix 7-F: Field Notes from Group Interviews

	Mutumbu Women's Group	Ginga Women's Group
Agroecological zone	North, high potential, small hectarage	South, Lake Victoria shore; one rainy season
Farming System	Mixed—commercial and subsistence; strong dependence on off-farm income; intercropping system common in food and cash crops	Subsistence mixed-cropping with some cash crops (cotton, maize, or fruits), one crop per year; most do hand tillage; fishing and livestock important
Group Profile	Clan based, well-to-do clan; nursery in operation with expansion underway; twenty-four women and two men at meeting	Low-income farmers of fishing village seeking to supplement cash income. Formal group is recent; previously labor exchange on-farm. Twenty-two women and two male elders present at meeting
Household types	Extended family groups headed by male elders; many female-headed subhouseholds (common cooking) with absentee (wage labor) husbands	Few female-headed households; women farm and men fish, but men help with farm and women process and market fish; extended family and polygamous family units; shared compounds; each adult woman manages her own plot with husband
Crops	Fruits: Eleven species; bananas, papaya, citrus, and mango sold for cash	Fruits: Six species; tamarind for cash
	Other: Eight species; onions, potatoes, maize, beans, groundnuts for cash; finger millet, sugar cane, cassava for subsistence only	Other: Eight species; sorghum (preferred, most resistant), maize (bad yields), groundnuts and cotton for cash. Stored food is women's property; food in fields is men's property

Continued on next page

Appendix 7-F, *continued*

	Mutumbu Women's Group	Ginga Women's Group
	Animals: Cattle (savings, long term), sheep, goats, chickens (sold often for cash)	Animals: Cattle, sheep, goats, chickens, one donkey, four oxen
Fuelwood	About half use charcoal in rainy season; fuelwood also purchased. Eleven species collected. Timber commonly purchased, though some sell	Six species listed; fuelwood needed for smoking fish
Fodder	Crop residues, napier grass, *Sesbania*, sodom apple; problem in dry season	Seven species listed (see below)
Most commonly used species	*Markhamia*—fuelwood, timber, handicrafts *Cupressus*—fuelwood, timber *Sesbania*—fuelwood, timber, fodder *Albizia*—fuelwood, timber, medicine *Eucalyptus*—timber	*Balanites*—fuel, subsistence fruit, fodder for cattle and pigs, spoons, building storehouses *Tamarindus*—fuelwood, fruit for sale, fodder in dry period for pigs and cattle *Markhamia*—timber, dry season fodder for cattle and pigs; preferred for furniture *Euphorbia*—fences, in very dry time fodder for goats; not liked *Cassia siamea*—timber, furniture, dry season fodder for goats
Planted in cropland	*Markhamia*—dispersed (agreement by two-thirds of group) *Sesbania*—dispersed (one-seventh of group) *Albizia*—lower density than *Markhamia* or *Sesbania* *Eucalyptus*—with sugar cane	*Markhamia*—left in cropland *Tamarindus* *Papaya*—planted *Cassia siamea*—infrequently; opinions divided over its effect

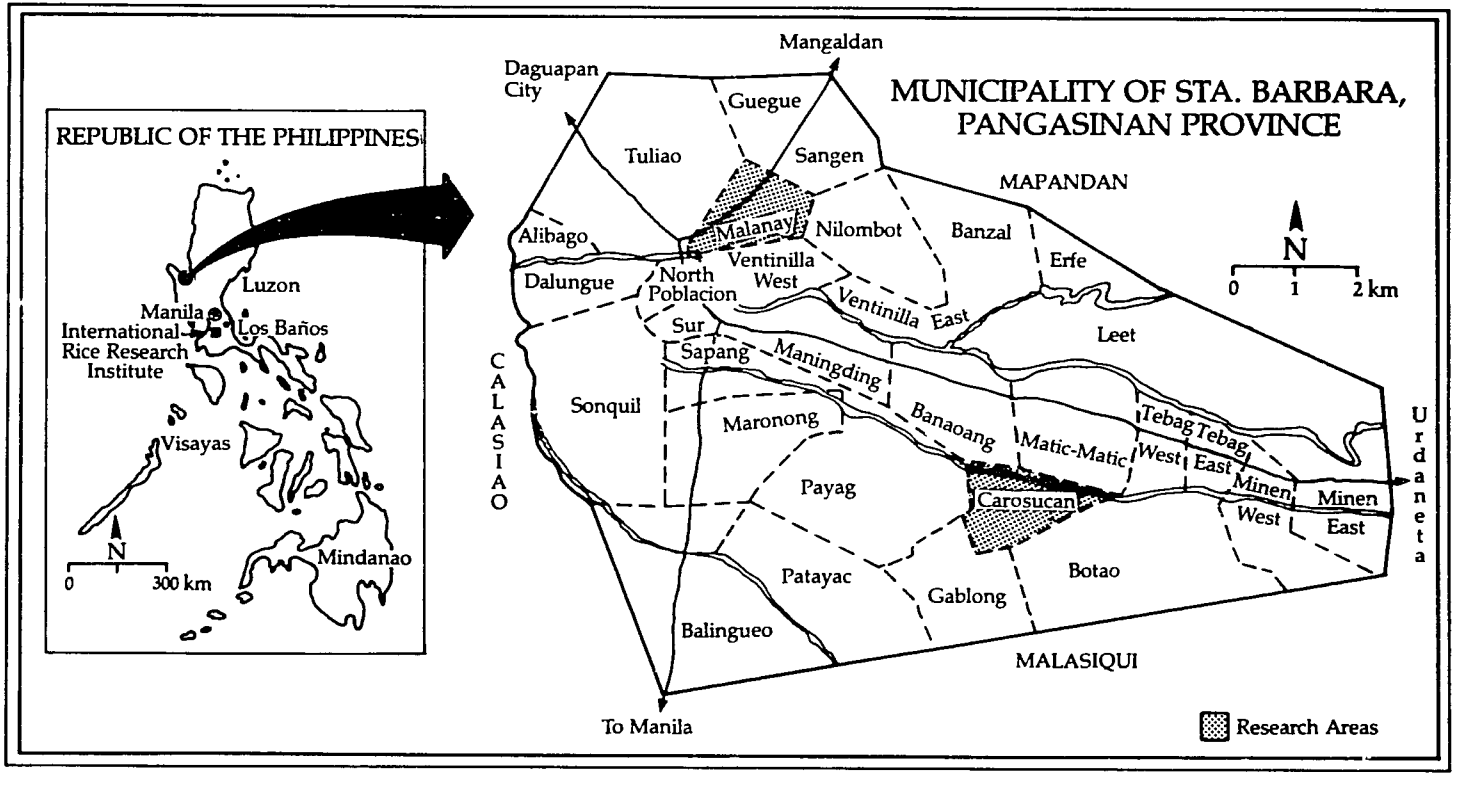
Main problems	Crop pests (striga weed, maize stalkborer, wild browsers, termites), soil fertility, ticks on animals, liver flukes (in people)	Rainfall, fishing catch (fish population disturbed), cash, fuelwood, cattle fodder, increasing land shortage
Possible planting sites	Cropland—about one-half Boundaries—all Woodlots—many Grazing land—few (a little on own farms) Home compound—most	Cropland—some Boundaries—all Woodlots—few Grazing land—few Home compound—most
Species suggested	*Markhamia, Albizia, Eucalyptus*	*Cassia* and *Eucalyptus*—for fuel and poles in boundaries and woodlots *Markhamia, Tamarindus*—in cropland *Balanites* and *Ficus spp.*—fuel, fruit, fodder; in cropland, fence, compound
Potential for trial sites	Eight people for trees in cropland	Most willing to try fence lines; four people will provide sites
Nursery objectives	Mix with commercial vegetable gardens, sell plants for cash seedlings for home planting	Vegetables for home, sale; seedlings for home, sale; want fruit, fuelwood, poles
Comments	Only two people have own grazing land; common use of some private plots and at roadways is major source of fodder. Off-farm income is a mainstay of the farm economy; major preoccupation of women's groups is for increased cash incomes, whether seedling-as-cash crop, fruit trees, poles for sale, or high-cost vegetable crops. Some interest in reduced spending for fuelwood; would plant more on farm	Hevay use of fuel for smoking fish; pay Ksh 5–8 per headload for fuelwood which will smoke twenty fish. Interest in replacing *Euphorbia* in hedgerows with fast-growing and more manageable fuelwood species. Men are present, employed, and actively interested. Economy of farm/fishing families is fairly commercial. Interest high for selling tree products or substituting own tree products for those now purchased, especially fuelwood used for smoking fish.

Appendix 7-G: Technology Prototypes, Best Bets: First Season

North, Higher Potential Zones	South, Lower Potential Zones
Alley-cropping Crop: Maize Species: *Leucaena leucocephala, Markhamia lutea, Gliricidia sepium* Spacing: Rows 4.25 m (trees) x 15 m (crops); within rows—maize 0.75 m x 0.3 m; tree seedlings; 0.5 m along the row	Alley-cropping Crop: Maize Species: *Leucaena leucocephala, Markhamia lutea* Spacing: (same as in North)
Fuelwood Species: *Cassia siamea, Grevillea robusta, Eucalyptus spp., Markhamia lutea* Arrangement: Woodlots	Living fences Species: *Parkinsonia aculeata, Prosopis chilensis*
Hedges and windbreaks Species: *Grevillea robusta, Cassia siamea*	

Figure 8-1

Map of the Municipality of Sta. Barbara, Pangasinan Province, the Philippines, Showing the Asian Rice Farming Systems Research Sites



Chapter 8

Philippines

Women in Rice Farming Systems, Crop-Livestock Project, Sta. Barbara, Pangasinan

THELMA R. PARIS

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Part 1 Benchmark Survey and the Introduction of the Women's Component

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Part 2 The Second Season, Experimentation and Innovation after the Introduction of the Women's Component (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

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Philippines: Part 1
Benchmark Survey and the Introduction of the Women's Component

BACKGROUND

The crop-livestock project in Sta. Barbara,[1] Pangasinan, was organized in 1984 as a collaborative activity between the Institute of Animal Science (IAS), at the University of the Philippines at Los Baños (UPLB), the Philippines Department of Agriculture, and the Rice Farming Systems Department and the Department of Agricultural Economics of the International Rice Research Institute (IRRI). This was an early effort to develop collaborative research by crop and animal scientists under the framework provided by the Asian Rice Farming Systems Network (ARFSN) and was funded by the International Development Research Centre (IDRC). A background on these institutions is given in Appendix 8-A. The major objective of the project was to improve existing farming systems through an integration of suitable crop and animal production technologies. Specifically, this project was developing ways of increasing utilization of crop by-products and residues as animal feeds through crop-livestock research.

FIRST YEAR OF RESEARCH

Site Selection and Initial Site Description

A team of scientists (an agronomist, an economist, and an animal nutritionist) from the cooperating institutions conducted a series of reconnaissance surveys to select a site in the Philippines which had potential for crop-livestock research. Secondary data were gathered and informal interviews with farmers regarding crop and animal production practices were conducted. Sta. Barbara, a town in Pangasinan, was finally chosen because of its nearness to major livestock auction markets, its potential for crop and livestock improvements, and its proximity to government support agencies and experiment stations. Within the town of Sta. Barbara, Carosucan, a rainfed village, was first chosen as one of the research sites followed by Malanay, an irrigated village.

	PHILIPPINES
Area	300,000 km^2.
Population	49 million.
Income	GNP/capita: $690; growth rate of 2.8%.
Topography	7,000 tropical islands; largest and most important is Luzon.
Currency	Peso. P 20.36 = U.S. $ 1.

	STA. BARBARA, PANGASINAN
Area	7,683 ha; 79.7% agricultural, 19.8% residential, 0.5% commercial.
Population	42,300; 50.3% female, 49.7% male.
Rainfall	2,248 mm/yr. Wet season: June–September; peak August 180 mm/wk. Dry season: December–March. Evaporation level: 1,892 mm/yr.
Temperature	Mean 27.9° C. Relative humidity is 77%. Average sun hours are 7.4/day.
Soil	Clay loam with pH of 6.7–7.9.
Crops	Rice is main crop; other crops are tomatoes, mung beans, corn, vegetables; mangoes grown widely in region.

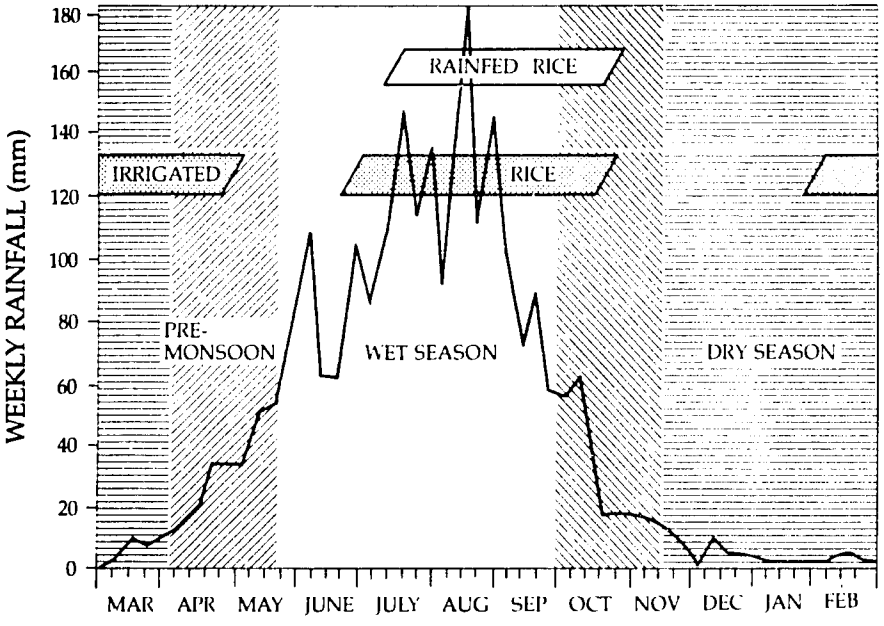
Sta. Barbara is around 262 kilometers north of Manila (Figure 8-1). This town is close to major trading centers like Dagupan City and Urdaneta, Pangasinan. The latter is one of the largest livestock auction markets in the country (Cabanilla 1984). It falls under a climatic type characterized by five to six wet months and three to four dry months. Rains come as early as April or May, but the peak level of rainfall comes around August (Figure 8-2). The soil is clay loam with a high pH of 6.7–7.9.

Malanay is located one kilometer east of the town proper and is traversed by the main highway leading to the commercial centers. The irrigated site is about 118 hectares, where 83 percent is lowland and 17 percent is upland. Before entering this village, there is an irrigation system which was installed by the National Irrigation Administration (NIA) in March 1972. The irrigation system enables the farmers to grow two rice crops in a year. The main rice crop is grown from July to October, while the second crop is grown from February to March, depending upon the release of water from the NIA. This leaves almost a one hundred-day turnaround time between the two rice crops (October to January) when no cereal crops are grown. The unirrigated upland area is planted to vegetables, mung beans, and pole *sitao* (beans). This village suffers from severe floods during the peak rainfall in August.

Carosucan is a strictly rainfed village. This village is around two kilometers from the road leading to the commercial centers and six kilometers from the town proper. Because of the bad road, very few vehicles come into this village. At the entrance of Matic-Matic, the village before

Figure 8-2

Average Weekly Rainfall Distribution and Rice Production Patterns



Carosucan, is an old irrigation system installed by the NIA in 1956. However, this irrigation system was used only from 1958 to 1960 due to high costs in maintaining the system. Carosucan is without electricity.

One high-yielding variety (HYV) rice crop is generally grown in this village, after which the lands are left fallow for livestock grazing. Upland crops, like local varieties of mung bean and cowpea, are grown depending upon the residual moisture. Rice is grown from July to October/November. The majority of the farmers grow traditional glutinous rice varieties for consumption, for sale and for *durumen*, a popular rice delicacy. Rice straw for the animals is stacked and piled in mounds after the harvest season.

Benchmark Survey

After the research sites were chosen, a list of full-time farmers was obtained from the village head. From these lists, forty and twenty-five households from Malanay and Carosucan, respectively, were selected for the benchmark survey. The benchmark survey was conducted by the staff of the Regional Integrated Agricultural Research Station (RIARS) of the Department of Agriculture. The purpose was to collect quantitative data on crop and animal interactions and data on problems in animal production

and management in rice-based farming systems. This was in order to better understand these systems and to design appropriate interventions to improve them. Four enumerators conducted the interviews which took one hour per questionnaire. Information about the household, off-farm and nonfarm work, size and utilization of landholdings, cropping patterns and calendar, animal health, utilization of crop residues, animal feeding practices, and constraints to crop and animal production were included in the questionnaire. The information on animal production and management practices included large animals only (carabao and cattle). Results of the benchmark survey are summarized in Table 8-1.

Cropping systems. The average landholding is just over one hectare. In Malanay, because of the irrigation, two rice crops are grown per year; in Carosucan most farmers fallow their land after the annual rice crop. Farmers were asked about possible new cropping patterns. At the rainfed site, 29 percent of the farmers expressed interest in rice-mung, rice-cowpea, and rice-corn patterns. In the irrigated area, less than 5 percent were interested in new cropping patterns.

Livestock. The large ruminants are an important component in the farming systems in the research site. Cattle and carabao are commonly raised, but cattle for draft and fattening are preferred in Carosucan. Both animals are also used for transporting crops from fields to market, as collateral to borrow loans from banks, and as an investment. Carabao and cattle graze during the dry season and are fed by cut-and-carry during the wet season. Supplemental feeding—generally rice bran, *Ipil-Ipil* (the leaves of the Leucaena tree), and corn leaves—was practiced by less than 20 percent of the farmers.

Planning and Design

Based on the results of the formal and informal surveys, the major constraints in animal production identified were lack of labor in caring for more than one animal, lack of cash or credit for purchasing an animal or for buying supplemental feeds, and lack of animal feeds during the dry season. In general, the animals in the area were undernourished due to the low nutritive value of the forages fed to them. For crop production, uncertainty of rainfall, lack of water, and lack of cash for inputs were the major constraints (Cabanilla 1984). The farmers' previous practices in mung bean production included the use of hired tractors for land preparation (which reduced residual moisture), the use of low yielding varieties, and the unscheduled frequency of pesticide sprayings (four times), even ten days before harvesting (this may be potentially harmful to humans and animals).

The team thought there was a potential for improving the existing crop and animal systems, particularly in the rainfed site. Upland crops, such as mung beans and cowpeas, that are grown after rice can provide

Table 8-1

Results of 1984 Benchmark Survey

	Malanay *(N=40)* (Irrigated)	Carosucan *(N=25)* (Rainfed)
Household characteristics		
Avg. age—operator (yr)	48	48
Avg. yr in school—operator	7	5
Avg. yr in school—other members	7	10
Avg. in households	7	5
Avg. no. working on farms	4	3
Landholdings		
Avg. area (ha)	1.3	1.6
Avg. no. parcels/farm	2.3	2.0
Avg. area per parcel (ha)	0.6	0.8
Land types (% total area)		
Upland	17	44
Lowland		
Rainfed	19	56
Partially irrigated	29	—
Fully irrigated	35	—
Rice varieties planted (% rice area)		
IR-36	24	21
IR-42	62	57
IR-54	14	2
IR-48	—	10
Traditional	—	10
Predominant cropping patterns (% land area)		
Rice-Rice	53	0.6
Rice-Fallow	32	78
Rice-Mung bean	4	12
Rice-Rice-Mung bean	4	—
Number of animals/village		
Cattle	19	17
Carabao	25	17

Source: L. Cabanilla and M. Ronduen (1984).

an additional net income of P 7,000 and P 5,000 per hectare, respectively. Aside from the additional income contribution, these legumes can provide protein for the family and the residues can be used as cattle feed, thus maintaining feed availability throughout the year, especially during the dry season. Given the farmers' circumstances, low-cost technologies for these livestock holders seemed appropriate for achieving the ultimate objective of the project: to increase productivity and farm income through integrated crop-livestock technologies. Simultaneous on-station and on-farm experiments were conducted to design and test alternative crop-livestock technologies.

On-station experiments. Two on-station experiments were designed for the determination of (1) the feeding value of crop residues, by-products, and forages, and (2) pesticide residues in rice and other crops fed to ruminants. The feeding value experiment was conducted by a female nutritionist from the Institute of Animal Science at UPLB, while the pesticide residue study was conducted by a female crop-protection specialist.

On-farm crop trials. The hypothesis for the rainfed areas was that existing farmers' practice (rice-fallow) could be improved with new varieties, better cultural management, and the addition of nonrice crops (legumes) into the pattern. Cropping pattern trials and component technology trials were designed by the agronomist for Carosucan: (1) component trials on a new rice variety, IR-60, for yield, (2) a new cropping pattern of legumes (mung beans or cowpeas) before or after rice, rather than fallow, and (3) improved varieties and practices for mung beans, including land preparation and insect control In the irrigated research site (Malanay), component technology trials (variety, fertilizer rates, ratooning potential[2] of the second crop, and fitting an upland crop in between two rice crops) were conducted. Cooperators for on-farm trials were selected by the agronomists.

On-farm crop and livestock trials. The feeding intervention to be tested was the supplemental feeding of *Ipil-Ipil* leaves, and, later on, rice bran to carabao and cattle. To test feeding interventions to ruminants, male farmer-cooperators from each site were selected. The farmers were selected based on their willingness to collaborate, and criteria were developed for on-farm cattle-fattening trials, such as they were taking care of either two animal units (control) or none at all. There were four treatments in the experiments: (1) one animal plus technology intervention on 0.5–1 hectare, (2) control of treatment 1, (3) two animals (one for draft and one for fattening) plus technology intervention on a farm 1.1–2 hectares, and (4) control of treatment 3. Farm size and animal number were the same for the control. Animals were provided by the project for the trials and were checked periodically by the male technicians. The frequency for cutting stems for higher herbage yields and the proper way of feeding the leaves was taught to the farmer-cooperators.

Record keeping and monitoring data. The economics staff of the Department of Agriculture with the guidance of the economists from IRRI gathered farmers' daily record keeping. Several types of activities were monitored and recorded on separate forms: daily livestock monitoring (including power use and livestock care and management), daily farm activities, daily household income and expenses, monthly livestock feeding, and seasonal crop input-output activities.

Testing and Evaluation of Technologies

The agronomist from the RIARS, under the guidance of the agronomist from the IRRI Rice Farming Systems Department, tested and evaluated the cropping patterns and component technology trials at both sites and collected data on the agronomic performance of crops.

The rainfed site of Carosucan.

1. IR-60, a new HYV rice, was tested and compared with the varieties used by the farmers. Cropping pattern trials of rice followed by either mung beans or cowpeas showed that IR-60 had significantly higher grain and fodder yields compared to IR-36 and IR-62, the varieties commonly grown by farmers.

2. Mung beans and cowpeas before and after rice were also tested, following the cutoff dates in the middle parts of May and November. When grown beyond mid-May, the legumes were killed by too much water.

3. New agronomic practices for mung bean production were also tested.

a) Furrowings done by water buffalo (carabao): upland crop cultivars tested after wetland rice with minimum tillage (furrowing only) to reduce moisture loss showed that mung beans, cowpeas, bush *sitao*, and peanuts gave yields under residual moisture, while soybeans and pigeon peas did not.

b) Results of the mung bean variety trial showed that for mung beans, IPB M79-13-60 and IPB M79-22-117 were the promising varieties. The grain yield advantages are 181 percent and 136 percent, respectively, over the farmers' local variety. For cowpeas and bush *sitao*, yields (green pods) have an advantage of 105 percent and 117 percent, respectively.

c) Three insecticide applications (2, 12, and 35 days after emergence): insect control trials on mung beans showed that three sprayings of insecticides at two and twelve days after emergence at the rate of 0.5 kilograms active ingredients (AI) per hectare of Azodrin and at ten days after flowering at 0.015 kilograms AI per hectare of Decis gave the highest marginal benefit cost.

The irrigated area of Malanay. Except for fertilizer rates and variety trials, the rest of the trials failed due to the uncertain release of water by the NIA. The mung beans were flooded at their flowering stage, and the potential of the main crop to ratoon was hindered as a result of lodging[3] caused by the flooding. Fertilizer trials showed that the economic levels were 80 kg N/ha for the dry season and 60 kg N/ha for the wet season. Varietal trials showed that IR-60 gave the highest yields during the dry season, although IR-58 gave the highest fodder yield. During the wet season, IR-218150-85-3-2 gave the highest yield (Godilano 1986).

Livestock feeding trials. The staff of the IAS collected data on animal weights (initial, bimonthly, and final weighings) and feed intake. The veterinarian of the Department of Agriculture monitored animal health. After three hundred days of feeding *Ipil-Ipil*, the live-weight gains did not reflect differences due to the intervention or farm size. A case study conducted by a sociologist revealed several reasons for the poor adoption of the *Ipil-Ipil* intervention. Farmers didn't understand the reasons for *Ipil-Ipil* feeding. Cattle preferred grasses to *Ipil-Ipil*, and the farmers were afraid that their animals would die when they ingested the larvae on the *Ipil-Ipil*. Also, collecting the leaves was considered a "bother" to the routine of the farmers (Juliano and Tolentino 1985).

Beginning in mid-April 1985, the experimental animals were fed with supplemental rice bran for forty-five days. The animals responded well with gains of 0.55 kilograms per day compared to 0.12 kilograms per day for the control.

INTRODUCTION OF WOMEN'S COMPONENT

In 1985, the Women in Rice Farming Systems (WIRFS) network at IRRI (see Appendix 8-A) decided to undertake action research in the two ARFSN research sites in Sta. Barbara, Pangasinan. This was part of a networkwide effort to develop mechanisms for considering women's concerns at the various stages of the technology development process in farming systems research. This methodology includes the following steps:

1. Identify women's roles in household and agricultural production.
2. Understand the factors constraining and supporting women's participation in farming systems.
3. Identify existing and future technological options that will enhance women's productive capacity.
4. Test and adapt selected technologies by user.
5. Assess different methods of collecting disaggregated data on gender.

The WIRFS team began by attending a workshop in order to learn about the overall objectives of the project, its various components, the crop and livestock practices and constraints, and the complexity of designing technologies for both crop and livestock activities.

When the WIRFS group evaluated the ways that ongoing research was integrating women's concerns, they found out that the benchmark survey dealt more with the animals than with the people who were and would be involved in crop and livestock activities. Although the research project ad-

vocated the farming systems approach, other livestock components like swine and poultry were not included. Information about swine management, which was women's responsibility and also an important component in the farming systems, was not gathered because the project's focus then was on carabao and cattle feeding interventions. Although two women (widows) were selected as cooperators, the farmers' wives were excluded in the meetings, field trips, and other activities. Also, the forms for the daily crop and livestock records on inputs and outputs provided space for recording information by gender, but the daily activities on management of large animals did not pick up women's participation. When the sites were visited, women were observed to perform such tasks as feeding livestock, tending grazing animals, collecting fodder, cleaning pens, and collecting dry cow dung for fuel. During the dry season, the majority of the men in the rainfed site sought off-farm employment as carpenters and left the management of the livestock to their wives.

To gain a fuller understanding of the farming systems, especially the interactions between the subsystems and how these affected the household members (particularly women), the WIRFS group used different methods in eliciting information about women: secondary data, informal surveys, participant observation, and focused interviews as well as a resurvey. A census of the two study villages was conducted by the WIRFS group to understand the population structures and women's situation within the population (see Table 8-2).

A sample resurvey using a revised form of the 1984 benchmark survey was conducted. The resurvey was intended to collect better information about subsystems and to test whether additional questions about labor participation, access to factors of production, and food consumption could be included at the start of the research process. Questions about animals included not only carabao and cattle but also poultry and swine. This time, questions were asked directly to women in the households. A sample of twenty-seven and twenty-six households from Malanay and Carosucan respectively were randomly selected, and the revised benchmark questionnaire was administered.

NEW INFORMATION FROM THE REVISED BENCHMARK SURVEY

Crop Production

The agricultural profile and cropping practices of the two sites are described in Appendix 8-B. There is a gender division of labor in crop production at both sites (Appendix 8-C). Although women are not involved in the application of fertilizer and insecticides, in general they are knowledgeable about the kinds, amounts, prices, and times of application of inputs since they are the ones allocating cash for farm inputs. They are

Table 8-2

1986 Census of Malanay and Carosucan

	Malanay (Irrigated)	Carosucan (Rainfed)
Demographic indicators		
Total population	1,523	849
Male	776	456
Female	747	393
Total number of HHs[a]	229	144
No. of HHs with land holdings	123	113
Male-headed, agricultural	80	88
Female-headed, agricultural	0	5
Male-headed, nonagricultural	34	9
Female-headed, nonagricultural	9	11
No. of HHs without land holdings	106	31
Male-headed, agricultural	21	5
Female-headed, agricultural	0	1
Male-headed, nonagricultural	71	19
Female-headed, nonagricultural	14	6
Total no. of extended families	26	18
No. of HHs with 3 families	3	1
No. of HHs with 2 families	23	17
Total land area (km2)	1.18	1.42
Population density (persons/km2)	1,291	598
Average HH size	7	6
Education		
Average years in school		
Head	7	6
Spouse	7	6
Land tenure classification (%)		
Owned	3	1
Share-tenancy	71	39
Leasehold	26	60
Tenant share arrangement (%)	50[b]	50[b]
Leasehold arrangement (cav/ha)[c]	15	12
Irrigation fee (kg/ha/yr)	250	—

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).
[a]HH = household.
[b]Under the share-tenancy arrangement, the landlord and the share-tenant each get 50% of the gross production.
[c]cavan (cav) = 46–48 kgs.

the custodians of the household cash. Women also are usually the ones who make arrangements for hired or exchange labor and who seek cash from informal sources.

The farming households draw from three primary sources of labor: family, hired, and exchange. Exchange labor is a common and major

source of labor in Carosucan. This is a reciprocal communal labor arrangement which provides a group of laborers working together on a particular task, rotating from one member's field to another. Food (morning snack or lunch), drinks, and cigarettes are provided by the farmer. Farmers prefer to use family labor (including relatives) for harvesting rice in order to get a larger share out of the gross production. They pay the threshers five cavans (46–48 kilograms per cavan) for every one hundred cavans threshed. Very few laborers are willing to pull and transplant seedlings, despite the higher demand for hired labor paid in cash, because most of the available laborers first have to fulfill their reciprocal obligations as exchange laborers.

In Malanay, a labor arrangement exists wherein the transplanters who are mostly men are not immediately paid after the service is rendered. They are given the right to harvest and thresh the rice crop in return for one-fifth of the gross harvest. Since the transplanters are men, very few women participate in harvesting.

Among those households which grew mung beans in Carosucan, women were more involved than men in broadcasting seeds, harvesting, threshing, and marketing. They also helped haul from the farm to the household, secure seeds and insecticides, and hire harvesters-threshers. In Malanay, land preparation and broadcasting seeds were mainly done by men while more women were involved in harvesting, threshing, and selling. In cowpea production, women were mainly involved in harvesting and selling rather than in planting.

Livestock Production

Appendix 8-C illustrates the specific activities for livestock production and who does them. Men are generally responsible for large animals (carabao and cattle), although women and children help. Collecting dung for fuel during the dry season is usually the women's task.

Swine and poultry management, feeding, and marketing are predominantly women's tasks. Proceeds from pig sales are kept by women. Informal interviews revealed that Leucaena leaves, locally called *Ipil-Ipil*, are traditionally fed to swine. About three hundred grams per day are usually fed to a piglet for fattening. *Ipil-Ipil* was found to cause abortions in pregnant sows. In times of scarcity during the dry months, hard decisions are often necessary as to whether rice bran and *Ipil-Ipil* will be fed to cattle or swine. Informal interviews with both men and women indicated that preference is given to swine because there are alternative feed sources for large animals.

Access to Factors of Production

Additional gender-related questions were asked regarding access to resources like land, capital, livestock, credit, information, organization,

training, and household income-generating technologies. Additional questions concerning food consumption and preparation were asked since it is normally the women's responsibility to secure and prepare food.

Access to land. At both sites, there is no distinct differential access to land by gender since lands in general are under share-tenancy and leasehold arrangements. Only 3 percent and 1 percent of the rice area in Malanay and Carosucan respectively are owned by the farmer-cultivators. Under the share-tenancy arrangement, the farmer-tenant has the right to till the land as long as he or she shares 50 percent of the total production with the owner of the land. Material inputs such as fertilizer and chemicals are equally shared by the tenant and the landlord, while payments for hired labor are borne by the tenant alone. In the irrigated area, the irrigation fee of 250 cavans per hectare per year is often paid by the farmer-cultivator. Under the leasehold arrangement, a fixed rental fee per season per year is given by the farmer-cultivator to the owner of the land, regardless of the total output. This leasehold fee is based on the average production of three cropping seasons. Usually the rental fee is higher during the dry season in the irrigated areas when yields are higher. Share-tenancy rights and leasehold arrangements are inherited by the widow in the case of the death of the male head of the family.

Access to livestock. Large and small animals are either bought or obtained through the *paiwi* system. This is a sharing system whereby the owner provides the animal while the caretaker is responsible for care, medicines, feeds, breeding, and other expenses. If the owner and the caretaker decide to sell the animal, the initial value of the animal will be deducted from the sales and the difference will be shared equally. If the female cow produces an offspring, the first-born calf will be given to the caretaker while the mother remains the property of the owner. This sharing arrangement is practiced more in cattle raising because the rate of turnover for cattle is faster than for carabao. Large animals are mostly considered men's property unless the head of the household is a widow.

In the swine raising system, piglets of the first litter are divided equally by the owner and the caretaker as are the income from sales of the pigs themselves. The owner and the caretaker do not deduct the initial investment before dividing the profits, as in the case of a cattle-sharing arrangement. The feed and care are all borne by the caretaker. The profits from swine raising are considered women's assets.

Access to credit. Informal interviews with men and women revealed that men have greater access to loans from the banks while women have more access to informal loans which have higher rates of interest. The sources of formal credit are the Rural Banks and the National

Food Authority (NFA). The agricultural nonsupervised loan from the Rural Banks requires a carabao, a cow, or a land title as collateral. However, since most farmers are either leaseholders or share-tenants who do not have title to the land they till, large animals are most often used as collateral. Widows who own title to a carabao or a cow can also borrow from the bank as long as there are guarantors. Because women are not formally organized and usually do not have any collateral such as land titles or carabao, they do not borrow from the bank.

The NFA credit is tied up with a marketing scheme in which farmers (providing they have the NFA passbook) can sell their *palay* (unmilled rice) at P 3.50, per kilogram, which is higher than the prevailing price in the market of P 3.00 per kilogram. Through the farmers' association, Samahang Nayon, farmer members can avail themselves of fertilizer loans at low interest without collateral. Any female member of the Samahang Nayon also can obtain this loan.

During the critical periods when farmers are most in need of cash for transplanting and for other household consumption needs (particularly rice, for food), the members of the households, especially the wives, resort to private moneylenders in the village. The credit scheme called *tampa* in the native dialect is common during the lean months. Through this scheme, the common practice is to pay fifty to one hundred kilograms of *palay* (worth P 150–300) for every P 100 borrowed to be paid after harvest. During the months of August to September and February to April, when rice supply is low, households either buy rice or borrow through the *tampa* lending scheme. Farmers who do not have cash sometimes borrow from the *palay* dealers.

Access to household technology. Women's access to improved household technology enhances their productivity. In the irrigated site, the women have access to conveniences such as sewing machines, refrigerators, and electric irons, since electricity is available there. Water is provided from pump wells near their households so access to water is not a major problem. In the irrigated site, households use rice hulls for fuel in specially made stoves. In the rainfed area the sample households tend to use wood for fuel, but, because of the increasing scarcity of bamboo and wood in the area, cow dung is popularly burned in special stoves that have been improvised by the households. In both areas, *Ipil-Ipil* wood is also used for fuel. Boat-shaped wood pestles are common in the households at the rainfed site. They are used for processing glutinous rice.

Access to education, training, and organizations. Training classes offered by the Department of Agriculture tend to be gender specific. Farmers' classes, azolla training,[4] and crop-livestock training classes are mostly attended by men, while nutrition and food preservation classes are mostly attended by women. There are no training classes for women

on vegetable gardening, swine and poultry raising, or on other income-generating activities which could provide useful additional knowledge and skills.

Access to food. Child malnutrition is evident in both villages as is very high rice consumption. The results of the nutrition and food survey are reported in Table 8-3.

Table 8-3

Nutrition and Food Consumption

	Malany *(N=27)* (Irrigated)	Carosucan *(N=26)* (Rainfed)
Nutritional profile		
Percentage distribution of children by nutritional status		
Malnourished		
Mild (first degree)	46	48
Moderate (second degree)	24	23
Severe (third degree)	6	3
Normal	19	23
Overweight	6	3
Food preferences		
Common cereal eaten	Rice	Rice, corn
Common legumes eaten	Mung bean	Mung bean
	Cowpea	Peanut
	Pigeon pea	Lima beans
	Soybean	String beans
Common vegetables eaten (both areas)	Camote tops, kangkong, malunggay, saluyot, eggplant	
Common meat eaten	Chicken, pork	Chicken, pork
Rice consumption		
Average daily per capita (kg)	0.65	0.53
Recommended daily allowance (kg)	0.32	0.32
Most common variety eaten	IR-42	IR-42
Months of scarce supply	Aug.–Oct.	Aug.–Sep.
Months of abundant supply	Nov.–Jan.	Nov.–Jan.
Months when bought from the market	Aug.–Oct.	Aug.–Sep.
Percent of households buying from the market	64	72
Food supply		
Months of food scarcity	Aug.–Oct.	Jan.–Apr. Aug.–Sep.
Persons responsible for buying food	wife	wife

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).

Access to income-generating activities. Farming is the major occupation of the majority of the households. Crop and livestock raising are the major farm activities. The uses of crop and animal production and their by-products are shown in Table 8-4. Price information for inputs and products are given in Appendix 8-D.

Fishing, working as hired labor in land preparation, transplanting, and hauling on other farms are the main sources of off-farm income for men. Carpentry, construction work, masonry, and pensions are the sources of nonfarm income. In Carosucan, eleven out of seventeen farmers sought nonfarm work such as carpentry, masonry, and construction work during the dry season, from January to March, leaving their wives and children to tend the crops (for those who were able to plant) and the livestock.

At both sites, women work as hired labor in pulling rice seedlings from July to August. In most instances, women pull the seedlings and men transplant them. On the average, a woman can pull 100–120 bundles of seedlings in a day. Women are generally preferred over men to pull seedlings because they do the job better and faster. Instead of bending down at the waist, the women squat on the wet soil to accomplish this task. The women complained of backaches and skin diseases due to prolonged immersion in water.

Table 8-4

Use of Crop and Animal Products and By-products

Product	Use
Rice grain	Food, sale
Rice straw	Animal feed, fertilizer, burned (Malanay only)
Rice bran	Animal feed, sale
Rice hull	Fuel
Corn grain	Food
Corn stover	Animal feed, burned (Malanay only), compost (Carosucan only)
Mung bean	Food, sale
Mung bean stover	Animal feed, fertilizer
Cowpea stover	Animal feed, fertilizer, burned
Carabao	Sale, power, breeding
Carabao dung	Fertilizer
Cattle	Breeding, fattening; power (Carosucan only)
Cattle dung	Fertilizer, fuel (Carosucan only)
Swine	Fattening, sale, breeding (Malanay only)
Poultry	Sale, breeding

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).

Fattening pigs is another activity from which women derive income within the homestead. Usually, piglets are raised for six months with an approximate profit of P 300. In Malanay, swine are mostly sold during the planting season (June and December) to finance rice inputs. The income from swine is also used for children's tuition fees in June. In Carosucan, the majority of the households sold swine in May during land preparation. Due to farmers' lack of cash, they paid hired laborers in terms of kilos of swine. During the dry season (February and March), proceeds from swine are used for daily food and household expenses. The low profits from swine management are due to the lack of knowledge in proper feeding and health care. Women earn additional income by selling vegetables and legumes (local varieties of cowpea) which they raise from small plots and upper bunds.

In October and November, when the resurvey was conducted, the seasonal, traditional income-generating activity of processing glutinous rice was taking place in Carosucan and was witnessed by the WIRFS research group. Glutinous rice is grown and harvested earlier than the hybrid varieties to take advantage of the seasonal market for the processed product. Glutinous rice is processed once a year and is an important source of nonfarm income for a majority of the women, particularly before harvesting the main rice crop. During this season, employment opportunities for women in the village are scarce.

ADDITIONAL RESEARCH

Income Monitoring

Cooperators for the WIRFS study were selected to represent different categories: landless, those with land, widows, and farmer's wives. Income data for the different family members were gathered on a weekly basis and summarized for the year (see Table 8-5). The income data revealed that the women cooperators contribute 13 percent of the total household income by processing glutinous rice. Although the areas planted to local glutinous rice varieties are small (645 square meters on the average), the importance of the crop as a source of cash for the household, particularly for women during the lean months, provides an incentive for the majority of farmers in the rainfed site to grow glutinous rice.

Focused Study of Glutinous Rice Production and Processing

In October and November 1986, a focused survey on a larger sample was done by the WIRFS researchers in Carosucan to find out the extent of involvement of men and women in this activity. The focused survey was conducted by one enumerator for three months. The interviews were con-

Table 8-5

Sources of Average Income of Farm Households, 1986

	Malanay *(N=18)* (Irrigated)		Carosucan *(N=17)* (Rainfed)	
	Peso	%	Peso	%
On-farm				
Crops				
Rice	4,774	34.7	1,917	17.7
Glutinous rice	—	—	984	9.1
Mung bean/vegetables	526	3.8	627	5.8
Subtotal	5,300	38.5	3,528	32.6
Livestock/Poultry				
Swine	1,750	12.7	969	8.9
Livestock	818	5.9	974	9.0
Poultry	32	0.2	29	0.3
Subtotal	2,600	18.9	1,971	18.2
Other farm income	844	6.1	484	4.5
Total on-farm	8,744	63.6	5,982	55.2
Off-farm				
Male Wages	871	6.3	240	2.2
Female Wages	281	2.0	124	1.1
Both	149	1.1	—	—
Total off-farm	1,301	9.5	364	3.4
Non-farm				
Remittance	716	5.2	1,804	16.6
Other business/lottery	1,530	11.1	388	3.6
Male (nonfarm)	1,248	9.1	873	8.1
Female (nonfarm)[a]	213	1.5	1,424	13.1
Total non-farm	3,707	27.0	4,489	41.4
Total income	13,752	100.0	10,835	100.0

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).
[a]Majority comes from buying, processing, and selling glutinous rice.

ducted during multiple visits because processing and marketing are done on a staggered basis.

Fifty-four women involved in processing and marketing glutinous rice were interviewed to determine the time spent in processing, the costs and returns to processing, and buying and marketing practices. Women in Carosucan process glutinous rice which is either produced on their own farms or bought from other farms. Processing the rice is a group activity, and it is not necessarily performed in an individual's own household.

Processing glutinous rice is very strenuous, consuming both time and fuel. Black glutinous rice was processed originally by burning the newly

harvested rice panicles, using bamboo for fuel. When all the burnt panicles had fallen off, these were hand-pounded alternately by two women using a wooden pestle and mortar, and then winnowed. These steps were done three times. By this method, processing a twelve-kilogram can of newly harvested glutinous rice would take about 15.5 hours (6 hours for burning, 6 hours for hand-pounding, and 3.5 hours for winnowing).

Because of the increasing scarcity of fuel and the increasing market demand for black glutinous rice, particularly during All Souls Day (November 1), which is a special Filipino holiday, an adulteration process (adding charcoal to blacken the husked grains) is now widely practiced. The present practice involves washing, parboiling, and drying the grains through continuous stirring with a long wooden ladle. The drying process is the most critical part because the grains should be gelatinized but not puffed. After drying, the grains are cooled for five minutes and then hand-pounded to separate the husks from the hulls, and the hulls from the grains. A second hand-pounding incorporates the charcoal with the husked grain to produce a black product that is preferred by consumers. In contrast to the original method, this method of processing a twelve-kilogram can of glutinous rice takes 4–6 hours. Cooking is mostly done by women while hand-pounding is alternately done by men, women, and children. An economic analysis measured the earnings for processing rough rice to black glutinous rice. The analysis showed that, on the average, a woman earns P 1.79 for every peso invested in processing glutinous rice, excluding labor costs (see Table 8-6).

Table 8-6

Costs and Returns of Processing Glutinous Rice *(N=54)*

Gross returns (A)	
174 kg at P12.50/kg (processed)	P 2,175.00
Cash costs	
348 kg at P2.92/kg (unprocessed)	1,016.10
Basin	45.00
Fuel	50.00
Transportation	80.00
Others	26.00
Total cash costs (B)	1,217.16
Net returns (A–B)	957.84
Cost of processing and selling/kg (B/174)	7.00
Net returns/kg ((A-B)/174)	5.51
Rate of returns to capital (5.51/6.99)	.79[a]

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986). Interview with individuals who are involved in processing and selling glutinous rice.

[a]For every peso invested, P1.79 can be earned.

Crop and Animal Production Constraints

The major problems expressed by women for mung bean and cowpea production are the unavailability of new seeds and losses due to pests during storage. A lack of capital for obtaining a piglet and high feed costs are the major problems in swine production. Women also lack knowledge of proper nutrition and health care for swine.

Low yields of traditional glutinous rice varieties and drudgery in processing are the major constraints in glutinous rice production. Due to the small amount of area planted to glutinous rice, women are required to go out from their villages to obtain the necessary supply for processing. Yields of the local varieties are low (three tons per hectare) and maturity dates are long (130–140 days).

The results of the surveys and other studies done by the WIRFS team were well received by the Sta. Barbara Crop-Livestock team. They and the WIRFS team met together to decide on priority areas for research during the coming year.

STUDY QUESTIONS

1. What were the major findings of the Sta. Barbara crop-livestock team during the first year?
2. What was known about the activities and resources of men, women, and children after the research done by the WIRFS project?
3. What are the benefits of production and who has access and control?
4. What recommendations do you have for research for the next phase?
5. Evaluate the diagnostic research undertaken throughout the project.

NOTES

1. *Santa* is regularly shortened to *Sta.* in Spanish, and thus in the Philippines, as in Sta. Barbara.
2. "Ratooning" is the putting forth of shoots from a plant after it has been cropped, producing a second crop.
3. "Lodging" is when the plants fall over and lie flat. This can be due to environmental conditions, such as flooding or hail, or because the plant is too heavy for its structure. Once lodging has occurred, plants often do not grow to maturity and/or cannot be harvested.
4. Azolla is the genus of a small aquatic fern that grows in ponds, canals, and rice paddies. The biological potential of azolla as a green manure is great. IRRI and the Department of Agriculture are encouraging farmers to use azolla as an organic complement to commercial fertilizer.

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Appendix 8-A: Agricultural Research Institutions

International Rice Research Institute

The International Rice Research Institute (IRRI) is a nonprofit agricultural research organization that is one of the thirteen International Agricultural Research Centers (IARCs). It is under the auspices of the Consultative Group of International Agricultural Research (CGIAR), which was founded in 1971 by donor agencies in order to provide long-term support for agricultural research in the developing world. IRRI was established in Los Baños, Philippines, in 1960 to breed better rice varieties and develop management technologies to help new varieties reveal their full yield potential. To accomplish this, IRRI works in close partnership with national agricultural research programs in rice-growing countries. Several international networks such as the International Rice Testing Program, the International Soil Fertility and Sustainable Rice Farming network, and the Asian Rice Farming Systems Network (ARFSN) were created by IRRI. IRRI's major contribution to rice science and development is in germ plasm (plant breeding and genetic conservation). Through the ARFSN, varietal trials of rice and crops grown before and after rice are being evaluated. The ARFSN emphasizes on-farm evaluation of new technologies.

IRRI has developed research procedures for applied farm level research in cropping systems, integrated pest management, agronomy, water management, soil chemistry, economics, and engineering. IRRI has training programs in genetic improvement, soil fertility and fertilizer evaluation, agroeconomic research, machinery design and testing, integrated pest management, water management, statistical procedures, agricultural communication, and farming systems. To increase IRRI's own capacity for innovative research it has links with universities and research institutions in developed countries, particularly in biotechnology. Other collaboration is through the "Prosperity Through Rice" program which provides training and demonstration of whole plant utilization, multiple cropping, and rice-livestock and rice-fish mixed farming systems to increase employment and income of the farm households.

The Crop-Livestock Research of the ARFSN

Collaborative on-farm crop-livestock research was formally implemented in the ARSFN in early 1984. The International Development Research Centre (IDRC) provided the funding to IRRI and the Philippine Institute of

Animal Science (IAS). The objectives of the research were (1) to promote collaborative research between crop and animal scientists through the ARFSN, (2) to analyze the relationships of the animal component to the rice-based systems and its importance to farm prosperity, and (3) to initiate research on relative component technologies for both crop and animal systems.

The types of research carried out in the ARFSN under the rubric of crop-animal research are very diverse. Trials are being carried out on (1) crop varieties (rice and leguminous crops); (2) forage crops; (3) pest and weed control as well as other agronomic practices; (4) forage crops on cropland (under perennials and/or wasteland and pastures); (5) cropping patterns; (6) animal feed supplement trials, including minerals; (7) herd health management; (8) animal breeding practices; (9) animal breed improvement; and (10) the expansion of the livestock enterprises as well as whole-farm, integrated crop-livestock research where both crop and livestock enterprises are improved simultaneously.[1] The farming systems methodology used by the ARFSN consists of site selection, the identification of problems and constraints, designing technologies to provide solutions to problems, testing and evaluating technologies, and pilot testing and adaptation of technologies with farmers' participation throughout the research processes.

Regional Integrated Agricultural Research Stations (RIARS)

The Philippines Department of Agriculture has RIARS in the thirteen regions of the Philippines. Each is mandated to test or verify potential new technologies that are tailored to local agroclimatic, soil, topography, and socioeconomic conditions. Each station also facilitates the transfer of new technologies to farmers by providing training to extension personnel and farmers. Sta. Barbara, Pangasinan, belongs to region I.

Women in Rice Farming Systems (WIRFS)

Explicit attention to women's concerns as users and beneficiaries of rice technologies began at the International Rice Research Institute (IRRI) in 1983, when a conference involving biological scientists, social scientists, and policy makers was convened to discuss women's roles in rice farming, whether women have benefited from the introduction of new rice technology, and how women might benefit from emerging technologies. In March 1985, IRRI participated in an Inter-Center Seminar on Women and Agricultural Technology at Bellagio, Italy, which discussed the incorporation of technology according to the user's perspective, specifically the role of women in the research programs of the IARCs. To develop greater

awareness of women's roles in agriculture and their special needs as technology users and beneficiaries, it was agreed that international and national agricultural research centers should develop long-term strategies to involve women, where possible, in all phases of research and technology development work.

In April 1985, a Project Design Workshop on WIRFS was held at IRRI. It was proposed that IRRI organize a network to collaborate with six Asian countries and undertake action/research projects. The ultimate aim of this collaborative work was to institutionalize women's concerns in agricultural and extension programs on rice-based farming systems. One strategy was to develop collaborative work in WIRFS within the Asian Rice Farming Systems Network (ARFSN) and IRRI's Cropping Systems Projects.

NOTE

1. M.G. Van der Veen, A.D. Calub, and L.L. Garcia. 1983. On Farm Crop-Livestock Research in the Asian Farming Systems Network: Data Needs for Site Description, Research Design and Testing. Discussion Paper presented at the Fourteenth Asian Farming Systems Working Group Meeting, Hangzhou and Beijing, China, 25–29 October.

Appendix 8-B: Agricultural Profile

Table 8-B.1
Summary Characteristics

	Malanay (Irrigated)		Carosucan (Rainfed)	
Crops				
Percent area planted to:				
HYV-HYV	69		—	
HYV-fallow	20		69	
HYV-mung bean (local)	4		12	
Glutinous rice-fallow	—		9	
Other patterns	7		10	
Cropping calendar				
Rice: first crop	Jul.–Oct.		Jul.–Oct.	
second crop	Feb.Apr.		—	
Mung bean	Jan.–Mar.		Nov.–Feb.	
Cowpea	—		Nov.–Feb.	
Squash	Jan.–Apr.		—	
Ave. farm size (ha)	1.92		1.19	
Ave. no. of plots per farm	6		4	
Ave. plot area (ha)	1.05		0.09	
Cultural practices and levels of technology				
Avg. method of crop establishment	Wet bed		Wet bed	
Avg. rice seeding rate (kg/ha)	113		128	
Frequency of plowing	2x		2x	
Power use	Rotavator/ carabao		Rotavator/ carabao	
Method of planting	Wet seeding/random		Random	
Frequency of fertilizer application[a]	2x		2x	
Use of basal fertilizer	None		None	
Percentage of rice plots sprayed with insecticides	80–100		30–40	
Methods of weed control	Spot weeding		Spot weeding	
Thresher use	Manual/big thresher		Big thresher	
Drying method	Sun drying on cement		Field drying	
Household distribution by animal holdings	No.	%	No.	%
Carabao + cattle + swine	7	(6)[b]	16	(14)
Carabao + cattle	8	(7)	7	(6)
Carabao + swine	15	(14)	17	(15)

Continued on next page

Table 8-B.1, *continued*

	Malanay (Irrigated)		Carosucan (Rainfed)	
Household distribution by animal holdings *cont'd*	No.	%	No.	%
Carabao	16	(15)	16	(14)
Cattle	14	(13)	21	(18)
Swine	34	(31)	12	(10)
Total	109	(100)	115	(100)
Animal/land ratio (no. ha)				
Carabao/farm	1:2.1		1:1.2	
Cattle/farm	1:2.2		1:2.5	
Avg. no. of carabaos per 10 farms	1.0		0.6	
Avg. no. of cattle per 10 farms	0.4		1.2	
Avg. liter swine size	9		6	
Avg. no. of farrowing per sow (in two years)	1		2	
Avg. monthly consumption of rice bran per pig (kg)	—		30	
Access to farm technology (%)				
Farms using modern rice varieties	100		100	
Farms hiring tractors	40		52	
Farms hiring big threshers	10		7	
Farms hiring carabaos	35		12	
Distance to nearest market (km)	1		6	
Persons responsible for buying:				
Farm assets	husband		husband	
Household assets	wife		wife	

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI. Benchmark Survey (1986).

[a]First fertilizer application 10 days after planting; Second application at panicle initiation.

[b]Figures in parentheses are percentages of total households raising animals for each village. 1951–70 average for the province of Pangasinan.

Table 8-B.2

Yields and Commercialization of Rice Varieties

	Yields (t/ha)	Commercialization (% operator's share sold)
Malanay		
IR-36	2.64	27
IR-42	4.30	55
IR-48	3.86	—
IR-62	3.62	13
Glutinous "diket"	2.80	21
Carosucan		
IR-36	3.57	20
IR-42	2.92	19
IR-48	2.72	16
IR-62	3.79	12
Glutinous "diket"	1.95	93

Source: Agricultural Economics Department, IRRI (1986)

Appendix 8-C: Contribution of Men, Women, and Children to Farm Operations[a]

	Malanay			Carosucan		
	M	W	C	M	W	C
		(N=26)			*(N=27)*	
Rice						
Seed bed preparation	85	12	4	89	4	7
Land preparation	73	—	—	85	—	7
Pulling	12	38	12	4	63	4
Transplanting	46	4	4	67	11	7
Broadcasting	81	—	—	78	11	4
Weeding	92	12	23	78	18	15
Fertilization	92	—	4	70	4	1
Spraying	88	—	—	63	—	4
Harvesting	46	27	8	89	33	26
Threshing	38	12	15	22	—	7
Hauling	65	—	—	82	11	11
Gleaning/stacking	8	8	—	15	22	11
Other postharvest	65	46	12	48	15	11
Buying seeds	38	—	—	1	7	—
Buying fertilizers and chemicals	62	31	—	74	15	—
Hiring labor	77	54	—	70	41	—
Selling products and by-products	38	58	—	41	26	—
		(N=26)			*(N=27)*	
Mung bean						
Land preparation	43	—	—	89	6	6
Broadcasting	57	—	—	6	50	22
Weeding	14	—	—	17	—	—
Fertilization	14	—	—	6	—	—
Spraying	43	14	—	50	6	6
Harvesting	29	43	14	61	67	22
Threshing	14	43	14	4	50	—
Hauling	—	—	—	44	28	6
Other postharvest	—	—	—	17	6	—
Buying seeds	—	14	—	22	22	—
Buying fertilizers and chemicals	14	14	—	53	17	—
Hiring labor	14	14	—	22	17	—
Selling products and by-products	—	57	14	17	39	—

Continued on next page

Appendix 8-C, *continued*

	Malanay			Carosucan		
	M	W	C	M	W	C
		(N=7)			*(N=14)*	
Cowpea						
Land preparation	33	—	—	75	—	25
Broadcasting	67	33	—	50	25	25
Weeding	—	—	—	50	—	—
Spraying	67	—	—	25	—	—
Harvesting	67	67	33	50	75	25
Threshing	—	—	—	25	25	—
Hauling	—	—	—	50	—	—
Other postharvest	—	—	—	—	25	—
Buying seeds	—	33	—	25	—	—
Hiring labor	—	—	—	25	—	—
Selling products and by-products	—	33	—	25	50	—
		(N=13)			*(N=18)*	
Cattle						
Putting up shelter	77	—	—	44	6	—
Preparing feeds	—	15	23	78	22	28
Feeding	38	8	72	39	39	94
Watering	92	23	23	83	28	44
Cleaning animal	77	15	89	17	28	83
Waste disposal	54	23	15	56	11	28
Gathering forage	92	8	8	61	22	50
Buying animal	69	—	—	33	6	—
Buying feeds	8	22	11	6	24	—
Taking animal to market	46	15	—	44	—	—
		(N=18)			*(N=17)*	
Carabao						
Putting up shelter	83	—	6	18	—	—
Preparing feeds	89	17	22	88	6	24
Feeding	28	11	76	18	59	—
Watering	89	17	6	88	24	59
Cleaning animal	22	17	76	24	29	—
Waste disposal	61	22	17	53	12	41
Gathering forage	83	17	6	82	12	47
Selling products and by-products	—	57	14	17	39	—
Buying animal	67	—	—	41	12	—
Buying feeds	—	—	—	—	—	—
Taking animal to market	17	—	—	53	—	—

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Appendix 8-C, *continued*

	Malanay			Carosucan		
	M	W	C	M	W	C
		(N=18)			*(N=17)*	
Poultry						
Putting up shelter	20	—	—	—	—	—
Preparing feeds	—	7	7	20	10	5
Feeding	20	93	40	25	35	45
Watering	—	33	7	—	—	5
Waste disposal	13	7	13	—	5	5
Buying chickens	—	—	—	5	—	—
Buying feeds	—	13	—	—	—	—
Selling products and by-products	—	—	—	10	10	—
		(N=18)			*(N=17)*	
Swine						
Putting up shelter	47	7	7	27	7	6
Preparing feeds	7	7	7	27	20	7
Feeding	13	80	13	20	87	20
Watering	13	53	7	—	73	—
Cleaning animal	27	40	7	—	87	—
Waste disposal	27	27	27	7	33	7
Gathering indigenous feeds	27	27	27	7	33	7
Buying animal	20	40	—	13	67	—
Buying feeds	13	60	7	13	60	—
Taking animal to market	20	53	—	27	20	—

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).

[a]Numbers refer to the percentages of men, women, or children who perform each operation.

Appendix 8-D: Price Information

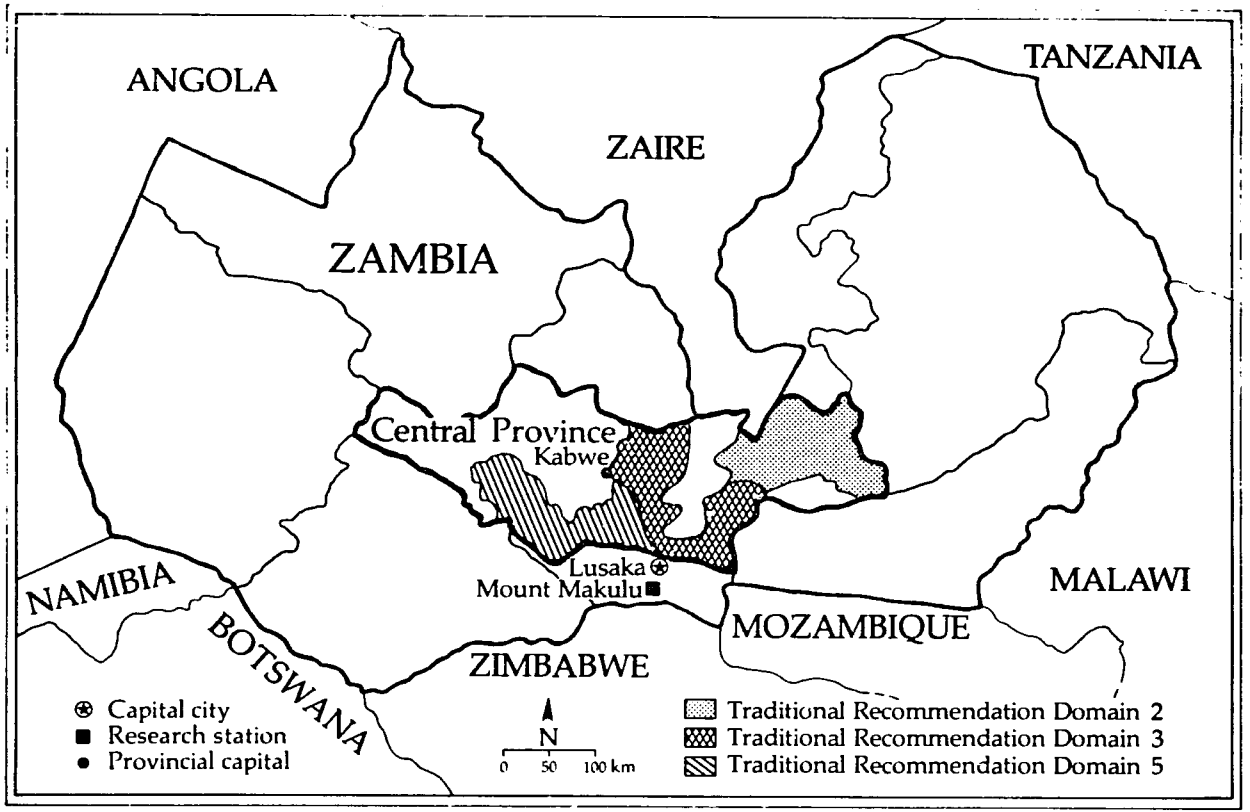
	Malanay (Irrigated)	Carosucan (Rainfed)
Price of rice (P/kg)		
August	4.50	4.50
October	3.50	3.50
Price of mung beans (P/kg)	—	11–17
Price of processed glutinous rice (P/kg)	12.50	12.50
Price of fertilizer (P/50 kg)[a]		
Urea (46–20–20)	265–285	
Complete (14–14–14)	244–265	
Price of chemicals (P/l)[a]		
Asodrin	160	
Malathion	93	
Price of rice bran (P/30 kg)	P/40	P/45–90
Interest rates (%)		
Formal	20–22	22
Informal (per 6 mo.)	40–60[b]	40–60[b]
Wage rates for rice (P/day)		
Clearing/cleaning bundles/pulling and bundling (per 100 bundles)/transplanting/spraying/fertilizing		
With food	20	20
Without food	30	30
Plowing/harrowing		
With food	42	42
Without food	55	55
Land preparation		
With carabao	P 60 + food + cigarettes	P 50 + food + cigarettes
With tractor (P/ha)	450	450

Source: WIRFS, Sta. Barbara, Pangasinan Survey, Agricultural Economics Department, IRRI (1986).

[a]Based on October 1985 prices.

[b]Borrowing is by *tampa*, a local practice wherein farmers borrow money or farm inputs from rice dealers or other individuals for their operating farm capital to be paid in kind during harvest time at a 40–60% interest rate.

Figure 9-1
Map of Zambia Showing Traditional Recommendation Domains in Central Province



Chapter 9

Zambia

Intrahousehold Dynamics and FSR/E in Zambia: A Case Study of Traditional Recommendation Domain 3 in Central Province

CHARLES CHABALA AND ROBERT N. GICHIRA

CONTENTS

Part 1 Country and Project Background and Results of Initial Diagnosis
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Appendix 9-A Activities for Understanding Farmers' Problems in Order to Produce Acceptable Recommendations
Appendix 9-B Prices, Costs, and Standards in Mkushi District

Part 2 Description of the Farming System and Problems Identified (in *Working Together*, Volume 2)

This case was prepared as a basis for discussion rather than as an illustration of either effective or ineffective handling of a project.

Zambia: Part 1
Country and Project Background and Results of Initial Diagnosis

Between 1981 and 1984, the Adaptive Research Planning Team (ARPT), located in the Central Province of Zambia, undertook a number of diagnostic surveys in order to understand local farming systems and determine promising agricultural research opportunities. As the time came to plan the next season's activities, the team members reviewed what they knew about the Zambian government's objectives, the characteristics of the local farming systems, and the farmers' views.

COUNTRY BACKGROUND

Zambia became an independent country on 24 October 1964. It is a landlocked country, lying on the Great Central African Plateau. It has a tropical climate and vegetation, with three distinct seasons. Like most parts of Africa, Zambia has experienced unreliable rainfall conditions since 1978, characterized by late arrival of rain, a short rainfall season, and inadequate rainfall. Such conditions particularly hurt small farmers who depend almost entirely on rains for growing their crops. Small farmers account for most of the maize production, and their drop in production, therefore, could not be easily absorbed. It led to drastic food shortages, especially for the urban population, and also a drop in the income of small farmers.

The marketed agricultural production is produced by large-scale commercial and small-scale commercial and subsistence farmers. The contribution to marketed maize production (the main staple and cash crop) by small-scale farmers was 46 percent in 1973. It rose to a peak of 70 percent in the 1976 season, and then declined to 60 percent and 46 percent in 1980 and 1981, respectively.

Zambia is the third-most urbanized country in Africa after Algeria and South Africa. The rural population is sparsely located in scattered settlements. The normal pattern of rural habitation is in small settlements and hamlets without any large well-nucleated villages. The uneven population distribution creates serious problems in providing social services. Women

	ZAMBIA
Area	753,000 km^2.
Population	6.44 million (1984 estimate based on 1980 census)
	43% urban; growth rate 3.1% per year. Density: 7.5 per km^2.
Income	GDP, 1975: K 1,584 million; 1982: K 3,564 million.
	Exports: copper (88%), agriculture (1%).
Resources	Mining (31%); agriculture (10%).
Elevation	1,000–1,300 m.
Rainfall	North: 1,000–1,400 mm; south and east: 600–1,100 mm.
Climate	Tropical. November–April: warm, wet season, long rains.
	May–August: cool, dry winter season (14° to 30° C).
	September–October: hot, dry season.
	October: short rains.
Vegetation	Woodland savannah.
Currency	Kwacha (K). 2.5K = U.S. $1 (1984).

	CENTRAL PROVINCE—MKUSHI DISTRICT
Population	Density: 3 per km^2.
Elevation:	1,000–1,200 m.
Rainfall:	800–1,000 mm; predominantly November to April.
Soils:	Generally sandy (Sandveldt) soils; pockets of heavier textured soils, *dambos*.

have a very small share of the jobs in the formal sector; only 8 percent of all employees in 1980 were females. However, in rural areas, women provide on average 60 percent of the agricultural labor.

According to a 1980 International Labor Organization (ILO) estimate of basic needs income, about 60 percent of Zambia's households were considered to have incomes below a basic needs level; of this, 85 percent were estimated to be living in rural areas. Health services in Zambia are provided by the government. In 1980 only 15 percent of the total population was outside twelve kilometers' reach of a health institution.

Primary schooling has long been compulsory for girls and boys, and women have been particularly encouraged to participate in adult literacy classes. Girls constituted 30 percent of secondary entrants and 15 percent of university students. The school year runs from mid-January to mid-May, mid-June to mid-August, and mid-September to the beginning of December.

Zambia is characterized by a diversity of cultures and tribal customs, with seventy-three tribal languages. Thus there are variations in the gender division of labor, particularly between districts and ecological zones. Division of labor depends on family structure, traditional and tribal customs, as well as the occupation of the household members.

PROJECT BACKGROUND

Agricultural Institutions

Prior to the 1980s, the organizational structure of the Ministry of Agriculture and Water Development (MAWD) in Zambia was characterized by a top-down flow of information. Both research and extension services were provided by the Department of Agriculture. However, each branch had its own substructure which operated independently.

Until 1982, research was coordinated from the central research station at Mt. Makulu in Lusaka and was carried out by the regional research stations and substations. The research was conducted by scientists working on multidisciplinary commodity research teams, with agricultural assistants in the extension service. The commodities included cereals, tubers, and oil seeds. There were 230 senior agricultural assistants and 604 agricultural assistants in the extension service. Of the senior agricultural assistants, 18 were women, and of the agricultural assistants, 23 were women. The agricultural assistants introduced new technologies and information primarily by selected on-farm demonstrations.

In 1981 the input supply and crop-monitoring functions were shifted from the parastatal National Agricultural Marketing Board (NAMBOARD) to the Central Province Cooperative Marketing Union (CPCMU). It was responsible for the distribution and sale of inputs and the purchase of agricultural produce at government-controlled prices. The Agricultural Finance Company (AFC), a quasi-government company, was the major source of credit for small farmers.

Formation of ARPT

In the 1970s a series of government and external evaluations found that the research structure had problems producing recommendations which could be rapidly adopted by the majority of Zambia's subsistence and small-scale commerical farmers. Realizing that almost 80 percent of the county's maize production (which was the principal food and cash crop) was from small-scale commercial and traditional, or subsistence, farmers, MAWD officials sought ways to make research of more relevance to small farmers. One strategy was to develop a standard unit of land measurement of appropriate size for small farmers and make recommendations according to that unit. This led to the establishment of LIMA recommendations. A LIMA is approximately one-quarter of a hectare (seventy steps by seventy steps), and the term *lima* means "to cultivate" in most of the languages spoken in Zambia. Fertilizer, planting density, and other recommendations were developed per LIMA for each province. The weakness of the program was that provincial wide recommendations still were not appropriate for all small farmers.

In 1980, MAWD responded favorably to a request by the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) East and Southern African economics program to demonstrate a set of procedures which could improve the research program. CIMMYT's demonstration was part of a larger effort to engage in and introduce on-farm research (OFR) to the region.[1] CIMMYT undertook zoning and problem identification stages in Central Province. Following these demonstrations, MAWD decided to reorganize research so that commodity research teams would have a national focus, and farming systems research and extension (FSR/E) an area focus. This led to the formation of a new adaptive research planning team (ARPT) in each province, consisting of at least an economist and an agronomist. A research extension liaison officer was assigned to each team. Their explicit objective was to work with subsistence and small-scale commercial farmers in order to increase productivity and improve family welfare. An ARPT has been established in each of Zambia's nine provinces, each supported by a different donor(s). Since 1981, the United States Agency for International Development (USAID) has been working with CIMMYT and MAWD in Central Province.

The ARPT brought together social and natural scientists who examined the different farming systems in order to plan and undertake adaptive research programs. The overall objective of the ARPT was to produce recommendations relevant to the needs of Zambia's subsistence and small-scale commercial producers in the hope of improving the farmers' output and welfare. The ARPT used the following strategy to reach these objectives:

1. Collect information on the different farming systems in Zambia which would be used to formulate relevant adaptive and applied research programs.

2. Undertake adaptive research especially on farmers' fields.

3. Improve the link between research and extension staff, through the program of on-farm trials.

4. Make information available to relevant institutions, that is, those dealing with extension, input supply, credit, marketing, etc., and assist them in preparing projects which would remove particular institutional and infrastructural problems facing farmers in different recommendation domains.

The ARPT worked closely with the commodity research teams and the extension branch. Within this structure, the ARPT supplemented biological parameters used by the commodity research teams with socioeconomic data to help shape the content of the applied research. The national FSR/E effort was coordinated by an ARPT leader in Lusaka, who

also maintained formal linkages with the extension branch and planning divisions within MAWD. CIMMYT had influenced the form and structure of FSR/E in Zambia from conception through regional implementation, and it continued to provide training assistance.

Central Province

The location of the Central Province in relation to the urban markets in Lusaka and the Copperbelt has given it a comparative advantage for commercial agricultural production, and, in the last decade, commercialization in the small farm sector has accelerated. As a result, the Central Province ranks among the most agriculturally productive regions of the country in terms of the total volume of maize produced and marketed. Since the early seventies, a few farmers have adopted new crops, particularly cotton, sunflowers, and soybeans. The latter two crops have been encouraged by government extension efforts to provide new resources for cooking oil. In recent years, the National Oil Extraction Board has not been able to buy enough groundnuts because of their popularity as a snack food. Research, input credit, extension and marketing services for cotton and soybeans are provided by the Lint Company of Zambia (LINTCO). Although maize remained the dominant starch staple and cash crop in Zambia, the Central Province also had the largest acreage of sunflowers, beans, groundnuts, sorghum, and millet.

The province has a low rural population density of about three persons per square kilometer, plateau characteristics with a consistent altitude of one thousand meters above sea level, and a rainfall period from November to April, which has a long-term average of eight hundred to one thousand millimeters. Most of the area under cultivation has a uniform topography with sandy (Sandveldt) soils, which are highly acidic, deeply weathered, and of low fertility. The exceptions are small pockets of heavier textured soils and low-lying drainage areas (*dambos*). *Dambo* areas generally are not cultivated in the wet season because of their high water table. They are used for dry and wet season grazing or are fenced for dry season vegetable gardens.

In 1976 there were sixty-six extension camps or extension locations in Central Province ranging from farmer training centers to school demonstration centers. There were sixty-eight extension staff each covering an area of approximately 263 square miles and over one thousand households.

Mkushi District

In the Mkushi District in Central Province, the predominant ethnic groups are the Lenge, the Swaka, and the Lamba. In recent years, a small number of migrants have moved in and are cultivating land allocated to them by village headmen. Most of the family households are headed by men, but an increasing number of women are now heads of households; the 1969

census shows that 24 percent of households in Mkushi District are female headed. This is because their husbands have migrated to urban areas for wage income. Others are widowed, divorced, or never married but have children. There is little interaction between male heads of households and female heads of households because of social disapproval of meetings between married men and unmarried women.

The contribution of women to the economy comes through their work as small-scale farmers, as managers of their households, and as nonfarm workers. Men do most of the heavy work of field preparation and share responsibilities such as planting, hoeing, weeding, and harvesting. Female heads of household undertake the heavy work, hire labor, or get help from male relatives or neighbors. The work load of women without husbands or with husbands or relatives away from home has increased drastically, while their ability to feed their families adequately has been affected by the shortage of male labor. Poor women put in longer hours than their wealthier counterparts since they cannot afford to hire labor. In household management, women undertake food processing and preparation, cooking, housekeeping, and child care, as well as collect fuel, water, and feed for domestic animals. This work time is shared with children.

Children start going to school at seven years. School-going children play an important role in farming households. Upon returning from school, usually about 1 P.M., children change from their school uniforms and, after a snack, join their parents with ongoing activities. Girls will usually go to the wells for water and clean the house and yards. Occasionally they will feed chickens and other domestic animals. They may grind mealie meal while cooking relish for dinner. During the agricultural season, after completing the household work, girls will join their parents in the field. During the dry season they will visit friends. After their snack, boys will normally join their parents in the field or take over tending cattle from their fathers. Older boys also will have responsibility for helping their fathers maintain the fence around the kraals and for helping to construct family houses.

Women and men are also engaged in nonfarm activities. Women are active in small-scale trade of food commodities and other household products. Over 90 percent of sellers in local markets are women. Men are more active in cash-crop production and sales, while women are involved in food crop markets. Markets are held frequently in larger villages, particularly after the harvest, and serve as intervillage exchanges. Usually these small businesses are self-financing.

In addition to their different labor roles, women and men have different access to assets and income and different financial responsibilities. Each sex earns and controls income from different crops or activities. Women are frequently responsible for their own and their children's food and clothing. Men's earnings frequently go toward the purchase of capital items, inputs and so on, and family expenses such as school fees for the children.

Oxen, used primarily for draft power, are a recent introduction and are not part of the traditional social system. They are generally owned by men, though some are owned by women. Men manage oxen for land preparation and other uses. Women who own oxen have their plowing done by male relatives or by hiring or exchange arrangements. Some farmers hire custom oxen or tractor operators for land preparation.

Land is readily available and is allocated by the village headmen. People do not cultivate all the area allocated to them. Female-headed households have access to land through the village headmen, and, once acquired, they can keep it for as long as they want. Generally, married women who prefer to have their own fields acquire land through their husbands or relatives; this also applies to junior males and females. In some instances, these assigned plots are part of the general rotation of fields farmed by the household.

Inheritance is largely patrilineal. When the head of a household dies, his or her relatives determine the inheritor, usually a son or nephew, who inherits the responsibility for caring for any dependents. The cultural view is that husbands know what is best for the household.

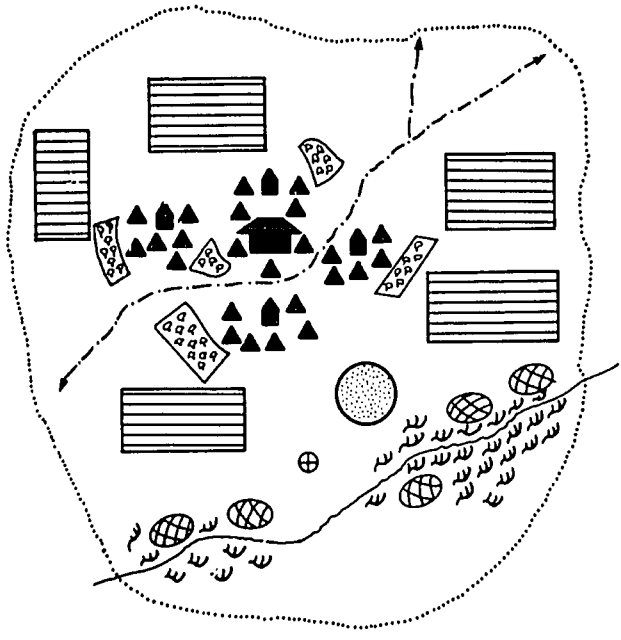
The common dish in Mkushi District consists of *nshima* accompanied by relish (a sidedish made with vegetables or meat). *Nshima* is a thick porridge made from maize meal, sorghum meal, millet meal, or cassava meal. The most preferred is made of white maize meal. The common relishes in Mkushi District are boiled beans, meat or chicken curry, and vegetables. Groundnuts are used as a substitute for cooking oil in the preparation of vegetables. *Nshima* is eaten during lunch and dinner. In between meals, snacks such as roasted groundnuts, fruits, and roasted or boiled green maize are taken. Popular beverages are sorghum beer and *munkoyo* . *Munkoyo* is nonalcoholic and is usually made from maize porridge into which the *munkoyo* root is put, dissolving the porridge into lumps of porridge and liquid. The mixture is sieved and the liquid drunk. It is particularly popular during the cultivation season as it can be taken to the fields. During the food shortage times, *nshima* is taken at dinner. During the day families depend on snacks, usually roasted maize and fruits such as mangoes, bananas, and papaya. A diagram of a typical village in the Mkushi District is shown in Figure 9-2.

ARPT ACTIVITIES

The multidisciplinary USAID and MAWD farming systems research and extension team in the Central Province was composed of positions for an agronomist, an agricultural economist, and a research extension liaison officer, which were filled by expatriates and Zambians. While agronomic and economic disciplines formed the core of each provincial ARPT, these

Figure 9-2

Diagram of a Typical Village in Mkushi District



Legend

- Village headman's house
- Independent households
- Housing for children and household dependents
- Backyard gardens for vegetables
- Main field for maize, sorghum, and millet
- Roads
- Dambo gardens (dry season)
- Cattle kraal
- Water well (ca. 1.5 km from village)
- River or stream
- Dambo areas
- Village boundary

Notes

1. On the average, main fields are about 1.5 km from the village.
2. Each village has only one kraal for all the cattle in the village.
3. Water wells are located near the rivers although during the wet season people may use another well close to the village.
4. The village boundary is usually determined by the area tribal chief, although the grazing grounds are communal for all the farmers in the area.

were supported by a rural sociologist and a nutritionist who functioned on a national level. Using a farming systems focus, the ARPT identified problems facing farmers and then concentrated on testing out possible technological solutions on farmers' fields under the conditions faced by the farmers. The sequence of activities used by the ARPT to understand farmers' problems and to determine acceptable recommendations is described in Appendix 9-A. The three initial diagnostic activities were a zoning survey, an informal survey, and a labor survey.

Zoning Survey

In October 1979, in order to identify different recommendation domains in the province, a CIMMYT team gathered information by interviewing field agricultural extension staff about agricultural activities in their areas. On the basis of this information, the different domains were delineated. A summary of the distinguishing characteristics of the six traditional recommendation domains (TRDs) as determined by the zoning survey is given in Table 9-1.

Of the differences that are apparent in Table 9-1, the most notable reflect the commercialization of agriculture in the farming systems. The heavy demand for maize in urban areas, in conjunction with the availability of hybrid seed, fertilizer, and credit at the local level, has facilitated the shift from traditional starch staple crops to commercial production. The ARPT determined that TRD2 was the poorest area, followed by TRD3. The ARPT initiated its research trials in TRD2 during the 1980/81 season, and then proceeded to TRD3.

TRD3 falls largely within Mkushi District and includes an estimated eight thousand farm households. It had six NAMBOARD buying points serving some thirteen hundred farmers each. The zoning survey indicated the following distinctive features:

1. A few farmers in four wards owned cattle, but limited ox-hire was reported in only three of these. The hoe was the dominant method of land preparation and the cultivated area was consistently reported as between one and two hectares.

2. Sorghum, the major starch staple, was the dominant crop in the domain. Finger millet was a secondary starch crop, mainly used for beer. Most wards mentioned some use of maize. A variety of relish crops was reported, but vegetables, particularly cabbage and rape, dominated the western wards and gave way to pumpkin leaves, beans, and groundnuts in the east. Fish was often caught by the farmers themselves, and chickens were also widely used.

3. Beer was predominant as a cash source, with temporary labor and charcoal also getting frequent mention. Cash sources were varied and small. Maize was sold by a few farmers in three wards, and local transactions of sorghum were prominent in three others.

4. No hired labor was mentioned in any ward. Four wards reported input purchases by a few farmers, almost exclusively seed and fertilizers for growing vegetables.

Table 9-1

Distinguishing Characteristics of the Six Traditional Recommendation Domains (TRDS)

	TRD1	TRD2	TRD3	TRD4	TRD5	TRD6
Land Preparation	Chitimene[a] Hoe	Hoe Ox hire	Hoe —	Ox hire Hoe	Ox Ox/tractor	Hoe Ox/tractor hire
Major starch staple	Cassava F.millet[b]	F.millet[b] Maize	Sorghum F.millet[b]	Maize F.millet[b]	Maize Sweet potato	Maize Sorghum
Major cash source	Fish Beer Cassava	Maize Beer Beans	Beer Temp. labor Sorghum Chicken	Beer Maize Charcoal	Maize Cotton Cattle sales	Beer Fish Chicken Maize
Hired labor	No	Yes	No	Yes	Yes	No
Purchased inputs						
Maize seed	Few	Many	No	Many	Many	Few
Maize fertilizer	Few	Many	Few	Many	Many	Few
Cotton	No	Few	No	No	Many	No

Source: M. P. Collinson, *Demonstrations of an Interdisciplinary Approach to Planning Adaptive Research Programmes* (1979).
[a]Chitimene—Slash and burn shifting cultivation with hoe culture.
[b]F.millet = Finger millet.

Informal Survey

The informal survey was conducted 12–21 October 1982. The purpose of the informal survey was twofold. One objective was to make a sample survey of the areas to check the characterization of the TRD established in the zoning survey. The second objective was to gather information to determine the farming systems in use and to help formulate on-farm research trials to overcome production problems. A total of twenty-four randomly selected farmers were interviewed by the ARPT staff in selected areas within TRD3. The survey work was aided by the close cooperation of the extension personnel in the areas surveyed. The informal survey involved group meetings with the selected farmers who were informally asked a variety of questions ranging from agricultural production to social organization, including how information was transmitted within an area. According to the informal survey, the characteristics of the small-scale commercial farmer are as follows:

Main starch staple	Maize, millets, sorghum, and cassava
Main inputs purchased	Fertilizer, seed, and pesticides
Main source of cash	Deliberate production of cash-crop surplus for sale, and sale of livestock; some production of new cash crops (cotton, sunflowers, etc.)
Power source	Hand and one or two pairs of oxen and oxen hire; possible tractor hire
Labor hired	Family, communal, and casual
Farm size	0.25–5 hectares

Table 9-2 summarizes the crop production of farmers interviewed during the informal survey; Table 9-3, sources of cash income in addition to crop sales. Farmers were reluctant to state how much of their production was sold or stored. Figure 9-3 shows the pattern of food shortages reported by these farmers.

Labor Use Survey

A supplementary labor survey was undertaken from November 1982 to October 1983. A detailed questionnaire was administered to ten households in TRD3 on a daily basis. The analysis of the nine completed surveys was finished in 1984. The survey was supervised by an ARPT economist, while the questionnaires were administered by an enumerator

stationed in TRD3. The main purpose was to find out the extent of the labor problems revealed in the informal survey. The survey was also expected to provide a better understanding of the gender roles. The number of workers and areas planted to different crops for each of the nine families are given in Table 9-4. Three of the families owned trained and untrained oxen and one family owned two cows.

FINDINGS FROM THE DIAGNOSTIC ACTIVITIES

Resources for Production

As mentioned earlier, access to land is unlimited. Land is either slashed and burned *(chitimene)*[2] or stumped (completely cleared). The latter is preferred for hybrid maize cultivation. However, cleared and stumped

Table 9-2

1981/1982 Crop Production *(N=24)*

	Number of Farmers	Average ha Cultivated	Average yield/ha (bags)	(kg)
Maize	21	2.2	11.6	1,044
Sunflowers	5	1.2	4.3	215
Cotton	3	1.2	—	218
Sorghum	2	1.2	11.0	990
Groundnuts	2	0.4	13.4	1,072
Beans	1	0.8	7.3	657

Source: Informal Survey (1982).

Table 9-3

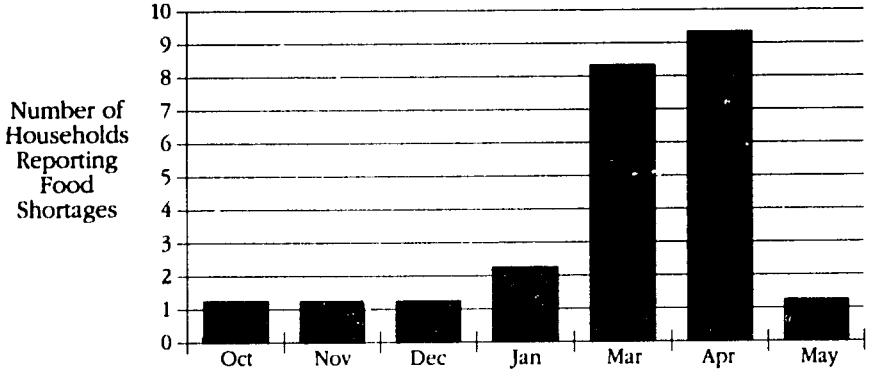
Sources of Income Other Than Crop Sales *(N=24)*

Source	Number of Farmers	Source	Number of Farmers
Selling beer	11	Selling groceries	1
Family remittances	7	Hiring out oxen	1
Selling vegetables	3	Selling bananas	1
Selling chicken and eggs	2	Working as a blacksmith	1
Selling fish	2	Working as a painter	1
Baking buns	2	Selling *munkoyo*	1
Working on other farms	2	Operating a grinding mill	1
Selling livestock	1	Making bricks	1
Selling charcoal	1		

Source: Informal Survey (1982).

Figure 9-3

Pattern of Food Shortages, TRD3



land is limited. This is because stumping is labor intensive and is mostly performed by male labor during February, March, and April. Cultivated areas usually consist of one or two major blocks of land with small subsidiary plots for groundnuts, beans, sweet potatoes, and other vegetables.

The purchase of hybrid maize seed (SR52 and ZH1) is common; a limited amount of vegetable and sunflower hybrid seed is also purchased. Fertilizer is commonly purchased and used. Recommendations for maize call for two applications: a basal application at planting and a top dressing when plants are about fifty centimeters tall, after about six weeks' growth. Because most farmers are not knowledgeable about pesticides and because pesticides are not readily available, their use is limited to very few farmers. The pesticides used are Gamatox for termites, DDT and Sevin for aphids, and Solbur and Endosulfan for cotton insects.

Oxen and tractor hiring constitute the major source of draft power. Farmers without oxen have access to them once the oxen owners finish plowing their land. Almost all the plowing is done by men with teams of oxen, usually a pair of oxen. If the plowing is done by a female farmer's relatives, she usually will pay them back in the form of exchange labor. However, most female-headed households depend on hired labor for plowing, and in such cases payment is usually in the form of cash. Ox-hire is also used for transporting crops from fields to market.

The bulk of the labor force is provided by household members, supplemented by hired labor during peak labor periods. Payment for hired labor takes the form of cash, mealie meal, exchange labor, beer, or access to oxen. Most communal labor hiring is for labor-intensive activities, weeding and harvesting, and occasionally for land preparation. A typical communal labor day is concluded with a beer party and food festivities. People attend the work parties for several reasons—they enjoy a party and they anticipate their own need for extra labor. A farmer is expected

Table 9-4

Relationship of Individual Crops Planted to Total Cropping Area in Hectares *(N=9)*

Farm No.	Work Force	Total Cropped Area	Maize	Sorghum	Sorghum and Maize	Ground-nuts	Finger Millet	Beans	Tomatoes	Sweet Potato	Cassava	Cabbage	Finger Millet and Maize
1	3	0.76	0.53	—	—	0.01	0.10	0.05	—	0.01	0.02	0.04	—
2	3	1.31	1.02	0.23	—	—	—	—	—	0.05	—	0.01	—
3	5	0.93	—	0.42	0.37	—	0.09	—	0.01	0.04	—	—	—
4	9	3.28	0.65	2.32	—	0.24	—	0.07	—	—	—	—	—
5	4	0.94	0.36	0.53	—	—	—	—	—	0.02	0.03	—	—
6	5	1.80	0.47	—	1.29	0.01	—	—	—	0.03	—	—	—
7	5	4.38	4.16	—	—	—	—	0.01	—	0.21	—	—	—
8	7	2.32	2.08	—	—	—	—	0.12	—	0.01	—	—	0.11
9	6	1.18	0.47	0.42	—	0.08	0.21	—	—	—	—	—	—
Totals	47	16.90	9.74	3.92	1.66	0.34	0.40	0.25	0.01	0.37	0.05	0.05	0.11
Avg. area planted[a]		1.88	1.22	0.78	0.83	0.08	0.13	0.06	0.01	0.05	0.02	0.02	0.11

Source: ARPT Labor Survey (1982/83).
[a]Total area planted divided by number of farmers planting.

to attend communal workdays if called upon by a farmer who attended his or her workday. Communal labor hiring is appropriately viewed as a kind of communal self-help scheme for neighboring villages as opposed to kinship groups, as people are not necessarily related to one another.

Crop Husbandry and Uses

Farmers prefer to eat the traditional maize that is mostly grown by women in small plots near their houses or in *dambos*. The traditional maize is usually eaten green. Most farmers also grow a hybrid SR52, which has been pushed by the local seed companies. Much of this is sold, but some is stored for food. NAMBOARD will only accept hybrid maize because of the inconsistencies in color of the traditional variety. Farmers say the hybrid is less sweet when eaten green, but indistinguishable when made into *nshima*. The recommended planting period for SR52 is November 15 to December 15, after which it will have a poor start.

Land preparation for all crops starts in September, just before the short, early rains in October, and continues through the end of December. The surveys showed that some farmers go on planting cereal crops up to mid-January. The common method of planting maize is dribbling behind the plow. The spacing for maize is usually seventy-five centimeters between rows and twenty-five centimeters between hills with an average of two seeds per hill. Sorghum, sunflower, and finger millet are commonly broadcast. Other crops such as groundnuts, pumpkins, beans, and so on, are usually planted in hills on tilled land.

For maize and sorghum harvesting begins with stooking, the stacking of sheaves of grain in the field. The cobs or grain heads are later broken off by hand. Maize is usually stored in bins or sacks. Sorghum and millet are stored almost exclusively in bins, while other crops are stored exclusively in sacks. Crop residues are either burnt, incorporated into the soil, or used as cattle feed. Farmers were reluctant to reveal how much of their production was stored and how much was sold. When asked how they decided how much to store, men responded, "Mother made a decision and I sold what was left over."

Institutional Problems

Farmers were interviewed about the services provided by agricultural institutions. They stated that access to credit from the AFC was limited and very unreliable. Small-scale farmers, who marketed their products to the provincial cooperative and marketing union, said payment was usually delayed. The inputs supplied by the cooperative were also customarily late. Further, local extension agents have very limited contact with farmers; new technology is introduced through selected on-farm demonstrations, which few female farmers attend.

Labor Use and Time Allocation for Major Crops

Family labor constitutes the major source of labor for farm operations. In peak labor-demand periods this is supplemented by hired labor. Based on a seven-hour day, male adults devote 75 percent of their time to farm operations while the other 25 percent is split up between nonfarm activities and resting. Adult females divide their time between farm operations and house chores such as cooking, fetching water, fetching fuelwood, and attending to children. Adult females have very little time to rest during the growing season. School-going children devote only 15 percent of their time to farm operations; most of the time they attend lessons at school. From August to October very little goes on; males spend this time relaxing, drinking beer, and socializing. However, females still devote almost 50 percent of their time attending to house chores. Fetching water takes up most of their time because most of the nearby wells are dry during this period. Cattle herding is mostly done by male children, while female children assist their mothers in house chores.

Maize cultivation. Maize is often grown on new land, and land preparation begins in September. The traditional maize grown in small plots is planted at the short, early rains in October and is harvested, to eat green, during January and February. Hybrid maize planting begins in November. Over one-third of the farmers reported using second generation maize seed, which they selected from the previous generation of hybrid seed. Research indicated this practice resulted in a 30 percent decrease in yields.

Basal fertilizer application is begun in December after full emergence. The second fertilizer application is made sometime between January and April. Fertilizer application rates in 1982/83 and 1983/84 were 135 kilograms per hectare for basal fertilizer and 140 kilograms per hectare for top dressing, down from what was reported in 1981 when the price of fertilizer was lower. Most farmers reported applying the same rate of fertilizer to late-planted maize; others applied greater amounts.

Farmers generally weed once, beginning in December and continuing through January and February. Some weeding goes on through April. A few farmers use pesticides to combat stalkborers and termites, the dominant pests.

Stooking and harvesting hybrid maize begins in May and extends through July. After the maize is shelled and packed, it is transported to market, some still being sold in September. During the peak labor period, December and January, farmers are forced to forgo optimal maize management (such as early planting and timely weeding) in order to cultivate other crops. Late planting, however, also results from the lack of draft power. Farmers who depend on hired draft power, the majority of whom

are female heads of households, are forced into a situation where they have to plant late because the common planting practice is dribbling the seed behind the plough.

Family labor is almost equally distributed for land preparation (after stumping), but planting and fertilizer applications are mostly carried out by children. Stooking is mostly a job for the husband or wife, while men mainly transport the produce from the field. Each family member contributes almost equally toward the total labor distribution for maize, with a slightly higher contribution from the head of the household (see Table 9-5).

Sorghum cultivation. Sorghum is the second major cash and staple crop, grown by 67 percent of the farmers. Its primary use is for beer brewing, though some of it is used for cooking *nshima* (porridge). A ninety-kilogram bag of sorghum will produce beer which sells for K 100. Sorghum is mostly grown by women, and the revenues realized from the sale of sorghum beer usually are controlled by them. Married women, however, may consult with their husbands.

Planting and preparing land for sorghum take place at the same time. Women broadcast the seed while men plow behind them with a team of oxen. This takes place from mid-November to early December. Four to five weeks after germination, when the plants are just slightly below knee-high, women thin out some plants and transplant them into parts of the field where the density is low; this ensures an even stand. The labor requirement for planting, therefore, is a summation of the labor for broadcasting and for transplanting.

Table 9-5

Division of Labor for Hybrid Maize Cultivation *(N=9)*

	Husband		Wife		Children		Hired Labor		Total	
	hr/ha	%	hr/ha	%	hr/ha	%	hr/ha	%	hr/ha	%
Prep. land	25	33	24	32	26	34	—	—	75	10
Plant	26	25	25	24	53	51	—	—	104	14
Fertilize	10	23	11	26	21	51	—	—	42	6
Weed	70	30	51	22	87	37	28	12	236	32
Stook	23	56	17	42	1	2	—	—	41	6
Harvest	31	28	27	24	31	28	23	21	112	15
Transport from field	39	84	2	4	2	4	4	8	47	7
Thresh and pack	18	24	24	32	—	—	32	44	74	10
Total	242	33	181	25	221	30	87	12	731	100

Source: ARPT Labor Survey (1982/83).
Note: Hours per hectare were calculated at the same rate for women, men, and children. Percents under Husband, Wife, Children and Hired Labor read across (totalling 100 percent); percents under Total read down.

It was observed during the survey that sorghum husbandry is very poor due to labor constraints. The calendar time for sorghum weeding is the same as that for maize, which is considered a priority crop. In addition, broadcast method results in random growth so that it is more difficult to weed. Sorghum is weeded two or three times. Sorghum is often planted on waste fields without any fertilizer applications. The seed rate ranges from six to twenty-two kilograms per hectare, though the LIMA recommendation is for three kilograms per hectare. Farmers select their seed based on the size of the panicle.

Sorghum grows eight to nine feet tall. As the grain matures, bird scaring is necessary from February (just before cutting and stacking the sorghum in the fields) through May (when the last of the grain heads are cut from the dried stalks). Because bird damage contributes to low sorghum yields, women spend almost twelve hours per day in the fields scaring away birds. This activity, according to the labor survey, accounts for well over 52 percent of the total labor expended in growing sorghum. During this period, women move to the fields for the day and use temporary shelters. The women's activities away from home include grinding maize and sorghum, preparing meals, washing clothes, and making baskets. In an effort to help their mothers, children sometimes miss classes at school.

To make beer, sorghum seed is germinated and then fermented for two or three days. Then it is dried and pounded into flour and made into a light porridge which is fermented for five to seven days. The light porridge is combined with a freshly made thick porridge of maize and sorghum and left overnight for further fermentation. The following day it is sieved so that a thin liquid remains. After another night of fermentation, the brew is ready for drinking. Local laws allow beer selling only on Fridays and Saturdays.

Finger millet cultivation. Finger millet is grown primarily by women. In December and January the seed is broadcast on flat land and then raked in. Land is not tilled in the conventional manner. Planting and raking appear in this report as planting. This activity takes up 25 percent of the total labor used for finger millet. Since it is grown on new land, weed infestation is minimal; hence, finger millet is not normally weeded. Bird scaring (April) and harvesting (May and June) take up most of the labor expended on finger millet (71 percent). Finger millet is mostly used for beer brewing and for cooking *nshima.*

Relish crops. Groundnuts, sweet potatoes, and beans (bush beans) are the primary relish crops. Sweet potatoes are mostly grown for home consumption as snacks and also for sale; the leaves of sweet potatoes are used as a vegetable, fresh or dry. Pumpkin leaves, too, are used as a veg-

etable, while the pumpkin itself is consumed as a snack, usually in between meals. Groundnuts are a very important relish crop. Dry nuts are ground into flour and are traditionally a woman's crop. They are added to vegetables as an alternative to cooking oil, which is difficult to acquire in rural areas. Fresh nuts are boiled and eaten as snacks or are roasted if dry; surpluses are sold for cash. Mt. Makulu Red is the favored nut variety for cash cropping. Though the price for groundnuts is high on the world market, the government price is low. Most groundnuts sold are sold privately though local markets. A persistent problem with groundnuts is "pops" (empty shells). Pops is usually associated with highly acid soils and the lack of calcium.

Relish crops are usually grown by women in small backyard gardens or near main fields or in the *dambos*. Land preparation is the women's responsibility for these plots. The average size of fields for these crops is 0.07 hectares, with a range of 0.05 to 0.09 hectares. Most operations are done with a hoe, and most labor used on these crops is expended on ridging and weeding. Harvesting groundnuts and sweet potatoes also tends to take up a lot of time. The harvest of dry groundnuts is in two stages: the plants are lifted upside down so that the nuts can dry and the nuts are hand-harvested a week or so later. Fresh nuts are dug directly from the ground. Groundnuts are planted from October through January. The harvest of the first plantings begins in February and continues through June. Groundnuts are stored in August. Sweet potatoes and other relish crops are planted January through March. Some cabbage and rape are planted in May.

Beans are grown by women in pure stands or are intercropped with other female-controlled relish crops such as pumpkins and groundnuts. Beans are in great demand bringing as much as K 100 for a fifty-pound bag on the informal market. The local varieties of beans produce a mixed crop when sown. White or sugar beans are kept for home consumption; red beans are sold in town. Beans have several plantings throughout the rainy season, the first in December. Successive plantings are harvested from April through July.

The hours of labor required for different activities for different crops per hectare and per average area planted are indicated in Tables 9-6 and 9-7. Appendix 9-B provides information on the prices, costs, and standards used by the ARPT in the economic analysis of on-farm trials. After reviewing these surveys, the ARPT team worked to characterize the farming system, to identify the major constraints and opportunities, and to plan its research activities for TRD3 for the coming season.

STUDY QUESTIONS

1. Why were the ARPTs created and what are their overall objectives?
2. What were the objectives of the ARPT activities in TRD3?
3. What are the activities of men and women in agricultural households and when are they done throughout the year?
4. What are the resources of men and women and what benefits do they derive from their productive activities? From other activities?
5. What are the primary constraints facing farmers in TRD3 and what are their causes?
6. For two of these problem areas, suggest solutions which might be tested and criteria for evaluating such tests.
7. Design an on-farm trial based on one of the solutions proposed. (optional)

NOTES

1. In 1980, when CIMMYT proposed to demonstrate these procedures in Zambia, farming systems research and extension (FSR/E), as it is known today, was just being recognized. There was great diversity in terminology and procedures among the many early practitioners. The CIMMYT economics program operating out of Nairobi, Kenya, was conducting what it called on-farm research. Most of CIMMYT's on-farm research at this time focused on maize, one of the key commodities of the organization headquartered in Mexico. In Zambia, FSR/E was initially called on-farm research or adaptive research, but by the mid-1980s, the term FSR/E was gaining acceptance. In this case, the generic term FSR/E is used for consistency among the different case studies in the volume.
2. "*Chitimene*" is slash-and-burn shifting cultivation. All growth is cut down and the field burned before cultivation. After the fertility of a field drops, a new field is opened by the same method.

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Table 9-6

Crop Labor Activities in Person Hours Per Hectare *(N=9)*

	Prep. Land[a]	Plant	Fertilize	Weed	Stook	Harvest	Transp.[b]	Thresh and Pack	Scare Birds	Shell	Total
Hybrid maize	75	104	42	236	41	112	47	74	—	—	731
Sorghum	60	98	—	361	—	701	17	—	1,345	—	2,582 (1,237)[c]
Finger millet	—	147	—	19	—	397	—	—	—	—	563
Beans	184	499	—	888	—	358	—	—	—	433	2,363
Sweet potatoes	851	665	—	—	—	421	—	—	—	—	1,938
Groundnuts	113	1,600	—	—	—	963	—	—	—	—	2,676

Source: ARPT Labor Survey (1982/83)
[a]The labor requirement for land preparation is an average between ox and hand cultivation.
[b]Transportation of produce from fields and, in a few cases, to marketing depot.
[c]Number in parentheses is total labor requirement less bird scaring.

Table 9-7

Crop Labor Activities in Person Hours Per Average Area Planted *(N=9)*[a]

Crop per Avg. Size	Prep. Land[a]	Plant	Fertilize	Weed	Stook	Harvest	Transp.[b]	Thresh and Pack	Scare Birds	Shell	Total
Hybrid maize (1.22 ha)	92[b]	127	51	288	50	137	57	90	—	—	892
Sorghum (0.78 ha)	47	76	—	282	—	547	13	—	1,049	—	2,014 (965)[d]
Finger millet (0.13 ha)	—	19	—	3	—	52	—	—	—	—	74
Beans (0.06 ha)	11	30	—	53	—	22	—	—	—	26	142
Sweet potatoes (0.05 ha)	43	33	—	—	—	21	—	—	—	—	97
Groundnuts (0.08 ha)	9	128	—	—	—	77	—	—	—	—	214

Source: ARPT Labor Survey (1982/83)
[a]Areas from Table 9-4.
[b]The labor requirement for land preparation is an average between ox and hand cultivation.
[c]Transportation of produce from fields and, in a few cases, to marketing depot.
[d]Number in parentheses is total labor requirement less bird scaring.

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Appendix 9-A: Activities for Understanding Farmers' Problems in Order to Produce Acceptable Recommendations

Activity	Objective	Participants	Duration
Zoning	Group farmers by their farming activities into different farming systems.	ARPT staff interview extension workers and community leaders	3–6 months
Survey	Study the constraints of each farming system to understand the farmers' problems and identify potential for development.	ARPT staff interview farmers using extension workers as enumerators	3–9 months
Research priorities	Formulate a program of applied and adaptive research which aims to solve the most important technological problems identified in the farming system.	ARPT staff with commodity and specialist research team staff plus provincial ARPT committee members	2–3 months
On-farm trials	Test, and, if necessary, modify the possible research solutions on farmers' fields under realistic conditions until acceptable solutions are found. The trials are conducted on 3–10 farms within the target area.	ARPT staff with the trial assistant provided from extension branch	2+ years
On–farm tests	Information about technological components or packages which are successful in on-farm trials are extended by various means, on-farm tests/ demonstrations, still within the target area. The level of adoption is monitored.	Research extension liaison officer with camp level extension workers	1–2 years
Recommendation release	Technological components or packages which are adopted by the majority of the farmers within the target area are released and extended to farmers throughout the farming system.	ARPT staff, CSRT staff, and provincial ARPT committee members	

Source: ARPT Annual Report (1984/84).

Appendix 9-B: Prices, Costs, and Standards in Mkushi District

	Price/Quantity[a]
Fertilizers	
Urea (46%N)	26.75/50 kg
TSP (44% P O)	28.45/50 kg
KCL (60% K)	23.75/50 kg
"X" compound (20–10–5–10)	26.75/50 kg
"D" compound (10–20–10–10)	26.75/50 kg
Limestone	5.80/100 kg
Transport cost	1.00/bag
Seeds	
SR52 maize seed	76.00/50 kg; K 17.10/10 kg
MN752 maize seed	86.00/50 kg; K 19.10/10 kg
ZSV-1 sorghum seed	42.61/50 kg; K 10.25/10 kg
CCA75 sunflower seed	47.60/50 kg; K 11.25/5 kg
Carioca bean seed	5.00/kg (est.)
Local bean seed	2.00/kg
Herbicides	
Gramoxone (5 l)	12.65/l
Primagram (5 l)	23.50/l
Gesaprim (5 l)	12.10/l
Roundup (5 l)	53.90/l
Custom rates	
Land preparation by hired oxen	67.25/ha
Land preparation by hired tractor	75.00/ha
Transport to or from depot	5.00/trip

Continued on next page

Appendix 9-B, *continued*

	Price/Quantity[a]	PD/ha[b]
Labor requirement standards		
Land preparation with oxen		11
Planting maize (separate operation)		15
Planting maize (behind plow)		3
Weeding maize with hoe		34
Harvesting maize		16
Stooking maize		6
Shelling maize		11
Fertilizer application		
Basal on surface		6
Basal at root level		8
Top dressing (covered)		8
Top dressing (uncovered)		6
Basal broadcast		6
Lime application		6
Insecticide application		
Spraying liquid		1
Banding granules		6
Depreciation on knapsack sprayer	14.50/ha	
Opportunity cost of labor		
During maize planting	7.50/PD	
Ordinary labor	1.50/PD	
Output prices		
Maize	23.32/90 kg	
Sunflower	27.88/50 kg	
Sorghum	26.90/90 kg	
Edible beans	1.50/kg	
Groundnuts	33.64/80 kg	

[a]Prices in kwacha.
[b]One person-day (PD) is equal to seven person-hours.

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