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For Seasonally Dry and Drought Prone Areas of Jamaica

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Abigail Susan Eaton

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A REVIEW OF A SILVOPASTORAL RESEARCH PROGRAM FOR SEASONALLY DRY AND DROUGHT PRONE AREAS OF JAMAICA

By

Abigail Susan Eaton

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ABSTRACT

A REVIEW OF SILVOPASTORAL RESEARCH PROGRAM FOR SEASONALLY DRY AND DROUGHT PRONE AREAS OF JAMAICA

By

Abigail Susan Eaton

A review of a silvopastoral research program was conducted. The program's overall goal was the integration of tree fodder growth and management knowledge with current small-scale silvopastoral management systems in Jamaica. This review of the program had three objectives: 1) examining whether the five phases of the program facilitated the on-farm research process; 2) determining whether the five phases of the program were useful in assisting the program to meet its overall goal; 3) consolidating findings gathered during these phases and providing further direction should similar agroforestry projects be taken on elsewhere. Key factors for conducting on-farm agroforestry research are presented. Among other things, findings indicate that a continuous exchange of information between on-station and on-farm research, good communication between researchers from different disciplines, timing of the phases of research, and feedback to and from the local community are important to the outcome and continuity of agroforestry research.

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The research process. Over the last three years I've learned that this process can mean very different things to different people. All of their perspectives are valuable, and I've tried to incorporate what I've valued most about each individual's perspective into my own philosophy of what the process should be. It has been a learning experience.

There are many people to whom I am grateful. My committee members Dr. Maureen McDonough, Dr. Douglas Lantagne, and Dr. George Axinn all enlightened me with their personal perspectives and guidance on the process. I thank them for that. Dr. Stanley Ries instilled in me a constant reminder of a need to maintain ethics and personal integrity throughout the process. It is something I shall never forget. Dr. Michael Gold added moral support and guidance and provided a "push" at times when it was sorely needed. The support staff in the Department of Forestry can not be recognized enough for their help in moving me and fellow graduate students through the maze of procedures required to receive a degree--a special thanks to Barb Anderson for her patience.

It is not possible to adequately thank all of my fellow graduate students and other friends for their support over the last few years. I only hope they know that I appreciate all that they've done for me and that in some way I have been able to return the favor.

Finally I want to thank my family, especially my parents Wayne and Gwen, for their unquestioning material and moral support at the times when it was most needed. It has made my life much easier. I regret that my father is no longer here to see the culmination of the process. But I believe that in some way he will know how much I appreciate what he has done for me and that he knows that I love and miss him.

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Chapter 1

INTRODUCTION

1.1 Introduction to the Project

Between March 1990 and July 1993, extensive research was conducted in Green Park, Trelawny Parish, Jamaica and Moneague, St. Ann through a cooperative effort of the Jamaican Agricultural Development Foundation[1] and the Department of Forestry, Michigan State University (the JADF/MSU Agroforestry Program). The project started with the premise that fodder trees are extremely valuable livestock feed resources that are underutilized in Jamaica (Roshetko 1991; Torres, 1983; Le Houérou, 1980; Pandy, 1982; Malla, 1988; JLA 1983). Under this premise the systematic incorporation of tree fodder into livestock production systems, particularly to improve dry season feed availability, might be warranted. Thus the ultimate goal of JADF/MSU Agroforestry Program was integrating tree fodder growth and management knowledge with current small-scale farming systems to develop a sustainable small-scale silvopastoral management system (Roshetko, 1991).

Five phases of research have taken place under the JADF/MSU Agroforestry Program. Two initial phases to study the indigenous knowledge of small cattle holders in Jamaica and conduct trials of potential fodder tree species appropriate to the area were developed. These two phases were designed to establish baseline information (biological and social) upon which future efforts would build (Michigan State University proposal to JADF, 1989). While a desire to lead into on-farm research, based on the results of the trials existed at this time, the additional three phases that were added to the program evolved as new students were recruited into the project (Dr. Michael Gold, personal communication). An on-station trial of potential fodder species in Moneague, and a study of indigenous knowledge of fodder trees and indigenous silvopastoral systems in Green

[1] The Jamaican Agricultural Development Foundation is a Jamaican non-governmental organization that focuses on assisting small-farmers.

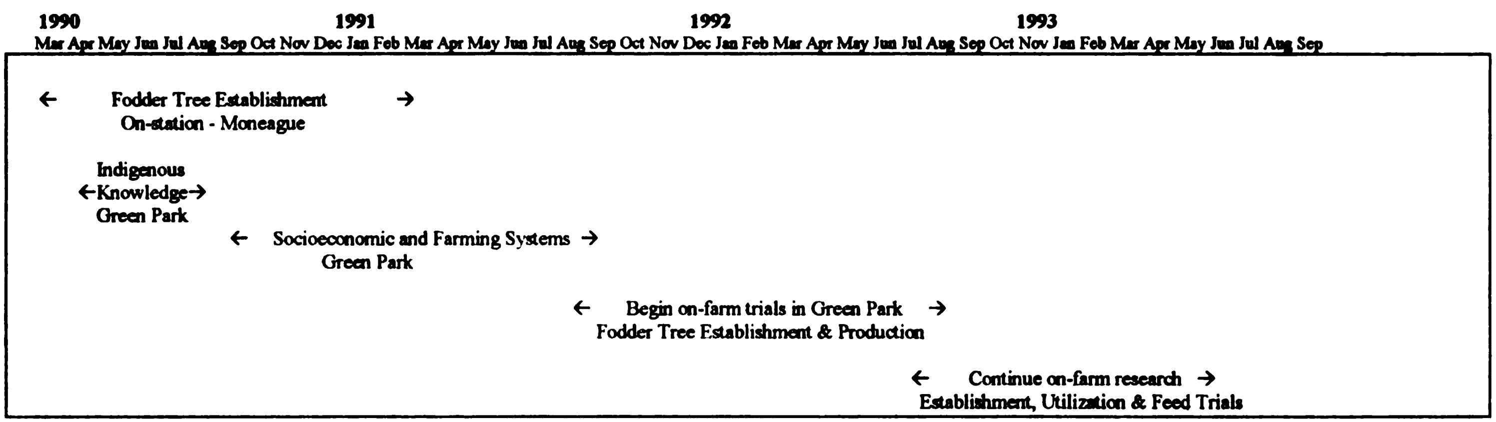
Park, were conducted concurrently (Roshetko, 1991; Morrison, 1991). These phases were followed by a year long study of socio-economic and farming systems with the intent of incorporating additional knowledge gained about local conditions into the on-farm research component (Andreatta, 1993). On-farm research began in 1991, taking the most promising species from the on-station trials, along with some favored indigenous species noted by farmers in the area, and testing them under farmers' conditions. Phase four tested fodder tree establishment and species' response to coppicing and other silvicultural practices (Krecik, 1993). Phase five continued the studies from phase four and investigated two species more in depth. In addition, the feed trials were conducted to observe palatability and cattle response to the fodder tree species (Morikawa, 1993).

Figure 1 illustrates the sequence of the phases of research conducted from March 1990 to July 1993. This is the period spent conducting actual field research in Jamaica.

1.2 Site Overview

Both Moneague and Green Park were selected by JADF at the outset as the sites for on-station and on-farm research. The willingness of Alcan (Jamaica) Company's Rio Hoe Farms to provide Michigan State University (MSU) full access to some of its land and resources, facilitated the execution of controlled on-station experiments and provided the primary impetus for JADF's selection of Moneague (Dr. Michael Gold, personal communication). Green Park, on the other hand, was selected as the site for on-farm trials because it is a drought-prone area, comprised of small-scale farms (Morrison, 1991), with a relatively large number of resource users raising livestock. In this instance, small scale cattle farmers are defined by Morrison (1991) as those having fewer than 40 head of cattle.

Figure 1. **JADF / MSU Agroforestry Program - Project Timeline ***



* This timeline refers only to those aspects of research conducted in Jamaica. Data analysis and subsequent individual project reports were completed at later dates, ranging from four months after the completion of field work to one and a half years

Green Park is a former sugarcane plantation. Bought in 1958 by the Kaiser Bauxite Mining Company, it was originally designed as a resettlement area for displaced residents from St. Ann Parish, living in an area that Kaiser wanted to mine. Potential resettlers were given the choice of land in Green Park or monetary compensation for land. In some cases the resettlers took the land in Green Park and later sold off parcels to inhabitants nearby, or to Jamaicans working abroad who returned and were looking for a place to settle down (what Andreatta (1993) terms "circular migrants"). It is unlike most areas in Jamaica, where farmers typically acquire their holdings through ancestral inheritance (Morrison, 1991; Andreatta and McDonough, 1992). Most of the community is composed of those who either relocated from nearby parishes, grew up in the area, lived outside the valley and purchased parcels from resettlers or other residents, or circular migrants. Only about 20 percent of the Green Park community are resettlers.

1.3 Study Objective

This paper reviews the JADF/MSU Agroforestry Program. There are three study objectives:

1. To examine whether the various phases of the program facilitated the on-farm research process.

2. To determine whether the various phases of the program were useful in assisting the program to meet its overall goal: the integration of tree fodder growth and management knowledge with current small-scale farming systems to develop a sustainable small-scale silvopastoral management system appropriate to dry and drought prone areas of Jamaica.

3. To consolidate the findings gathered during these phases in order to better understand reasons for either succeeding of failing to meet the goal of the project as well as provide further direction should similar agroforestry projects be taken on elsewhere, if not returning to Green Park itself. Were project phases effective at building a base of knowledge and awareness for facilitating the implementation of subsequent project phases?

Thus, by examining the research conducted from 1990 to 1993 under the JADF/ MSU Agroforestry Program, information on indigenous knowledge, socioeconomic factors and farming systems, and biological research and tree fodder production systems are consolidated to further define strengths and weaknesses that may be built upon (or avoided) in the future.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The JADF/MSU Agroforestry Program was an on-farm research program for the eventual development of sustainable small-scale silvopastoral management systems appropriate to dry and drought areas of Jamaica. The literature review focuses primarily on lessons learned about on-farm research to date. Initially the literature review addresses the field of agroforestry. Discussed are the importance of agroforestry, how agroforestry should be conducted, and why on-farm research is important in agroforestry. Literature pertaining to on-farm research for both agriculture in general and agroforestry are tapped because there is a great deal to be learned from the longer history and experience of on-farm research for agriculture. Factors pertaining to on-station and on-farm research linkages, farmer participation, assessment of characteristics, needs and constraints of farming systems and communities, experimental considerations in on-farm research, selection of farmer cooperators for on-farm research, and research teams and collaboration for on-farm research also are addressed. Finally, considerations for evaluating on-farm research and agroforestry programs are discussed. Based on findings from the literature review, research questions are then formulated to guide the study.

2.2 Agroforestry - Why and How?

> Agroforestry is a collective name for land use systems and technologies in which woody perennials (trees, shrubs, bamboo, etc.) are deliberately combined with herbaceous crops and/or animals, either in some form of spatial arrangement or temporal sequence. In agroforestry systems there are both ecological and economic interactions among the different components (Raintree, 1987).

As a focus of organized scientific activity, agroforestry is relatively new in comparison to that of agricultural crops (Raintree, 1991). Yet farmers worldwide have utilized agroforestry techniques as an integrated approach to land use for hundreds of years. Indeed, as Nair (1993) states, agroforestry would seem to be a new name for a set of old practices in many nations.

Agroforestry represents an interface between agriculture and forestry and encompasses mixed land use practices. These practices have been developed primarily in response to the special needs and conditions of resource poor farmers in tropical developing countries that have not been satisfactorily addressed by advances in conventional agriculture and forestry (Nair, 1993). During the Green Revolution[2] many high yielding cereals and related technologies were developed that placed a high demand on increased fertilizers use and other high-cost inputs. While these crops are very productive, they are also beyond the reach of many resource-poor farmers in developing countries (Nair, 1993).

Realizing that something must be done to address the needs of the resource-poor, there was a resurgence of interest in the concepts of intercropping and integrated farming systems. These were recognized as systems that are both familiar and relevant to the resource-poor farmer. This resurgence, combined with increasing concerns about the environment, especially tropical deforestation, eventually led to many studies that showed the advantages of combined production systems of crops, trees and animals (Nair, 1993).

There is a consensus that agroforestry is practiced for a variety of objectives (Nair, 1993). Nair (1992) identified at least 18 common yet distinct agroforestry practices (Table 1). Of interest to this study are the variety of practices that come under the label of silvopastoral or agrosilvopastoral systems. In silvopastoral systems, trees are

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[2] The Green Revolution represented a period during the 60's and early 70's when several International Agricultural Research Centers (IARCs) and the Consultative Group on International Agricultural Research (CGIAR) undertook research with the objective of enhancing the productivity of major agricultural crops and animals of the tropics.

Table 1. Common Agroforestry Practices in the Tropics (Nair, 1992)

Agroforestry Practice	Arrangement of Components
Agrisilvicultural Systems	
Improved tree fallow	Woody species planted and left to grow during the "fallow phase."
Modified taungya	Combined stand of woody and agricultural species during early stages of plantation establishment.
Alley cropping/hedgerow intercropping	Woody species in hedges; agricultural species in alleys between hedges; microzonal or strip arrangement.
Home gardens	Intimate, multistory combination of various trees and crops around homesteads
Plantation-crop combinations	Shade trees for crops; intercropping with crops; integrated, multistory mixtures of plantation crops; mixtures of plantations in alternate arrangements.
Multistory tree gardens	Multispecies, multilayer dense plant associations with no organized planting arrangements.
Windbreaks and shelterbelts, livehedges	Trees around farmlands / plots.
Trees in soil conservation and reclamation	Trees on bunds, terraces, raisers, etc., with or without grass strips.
Multipurpose trees on croplands	Trees scattered haphazardly or systematically on bunds terraces, or plot / field boundaries.
Fuelwood lots	Interplanting fuelwood species on or around agricultural land.
Silvopastoral Systems	
Trees on rangeland or pastures	Trees scattered irregularly or systematically.
Silvicultural Systems	
Fodder banks	Production of protein-rich tree fodder on farm / rangelands for cut-and-carry fodder production.
Agrosilvopastoral Systems	
Plantation crops with fodder and livestock	Cattle under coconut crops (example).
Home gardens with animals	Multistory combination of various trees and crops, as well as animals around homesteads.
Multipurpose woody hedgerows around homesteads	Woody hedges for browse, mulch, green manure, soil conservation, etc.
Other (Special) Practices	
Apiculture with trees	Trees for honey
Aquaforestry	Trees lining fishponds
Multipurpose woodlots	Various purpose (wood, fodder, soil reclamation, etc.)

incorporated into pasture and/or animal production systems. Practices range from relatively simple, i.e. planting trees on rangeland or pastures, to combining plantation crops with fodder and livestock.

A great deal has been written about the potentials for agroforestry over the last 15 years. However there are several characteristics of agroforestry that complicate the research process including poor understanding of farmers' socioeconomic backgrounds and technical agroforestry strategies, lack of basic technical information about agroforestry systems and components, system complexity and variability, lack of locally validated agroforestry technologies, and lack of data for agroforestry research and development policy (Scherr, 1991). The extremely site-specific nature of agroforestry, conditioned by biophysical and sociocultural characteristics, poses serious difficulties in defining precise recommendations of wider applicability (Nair, 1992; Scherr, 1991). Despite this, development agencies and donors with a global mandate to addressing the needs of both the resource poor and the environment, need information to formulate policy on agroforestry with a wider applicability to more regions in the world (Nair, 1992). Nair (1992) asserts that in order to channel development assistance to agroforestry programs, researchers must develop and provide specific recommendations on the most appropriate agroforestry systems and practices for different parts of the world.

Raintree (1983) states that the design of a program for research on agroforestry interventions must be based first upon the diagnosis of the farming system. Unlike much agricultural commodity research that is both established and has research validated technologies for production of individual crops (Röling 1982, p98), agroforestry has only a few such technologies. In the former, farming systems research (FSR) was developed to identify constraints to adopting existing technologies and as an attempt to adapt technologies to meet farmers' circumstances. Farming systems research departed from previous agricultural research approaches by focusing analysis on households rather than solely on crops (Buck, 1990). In agroforestry, however, in view of what Raintree (1991) terms the "relatively undomesticated nature of the vast majority of trees used in agroforestry," technologies and designs need more research before they can be recommended for adoption. This factor, along with the complexity and scope of agroforestry systems, led the International Center for Research in Agroforestry (ICRAF) to a variation of the farming systems perspective as a method that could deal comprehensively with the field of agroforestry.

In 1981, ICRAF began to develop a FSR based approach appropriate to agroforestry research known as "Diagnosis and Design" (D&D) (Raintree, 1987). Beyond the diagnosis of problems or constraints in standard FSR methodology, D&D must also design and evaluate potential technologies from which research needs and requirements might be derived. Raintree (1990) adds that at a micro-scale (e.g. household and farm level) D&D is quite consistent with the general pattern of FSR and that D&D methods might be considered an agroforestry-specific variant. Nevertheless, when ICRAF initiated systematic work on the development of a diagnostic methodology for agroforestry, there was the thought that this work would eventually lead, through trial and feedback, toward a single optimal set of procedures for agroforestry research (Raintree, 1990). However, as researchers gained experience with D&D in different settings with different collaborators, rather than developing one optimal set of methods, users had different needs and resources and preferred to use different adapted forms of the same underlying logic (Raintree, 1990). In comparison to FSR methodologies (Shaner et al, 1982), Raintree (1990, p. 44) notes that the most distinctive features of the D&D methodology that clarify its underlying logic include th following:

> 1) a unique focus on the role of trees within the whole system (and hence a larger diagnostic scope relative to agricultural commodity-based technology).
>
> 2) a basic needs approach to identifying and evaluating household production subsystems in terms of the farmer's objectives (i.e. specifying components of the farming system in terms

of their role in satisfying basic household needs).

3) a trouble-shooting procedure for identifying critical constraints, leverage points, and functional specifications for agroforestry interventions (through a great emphasis on the iterative nature of the basic D&D process).

4) a separate assessment of the sustainability of the land-use system under the most likely future scenario.

In a review of agroforestry practices in sub-Saharan Africa, Cook and Grut (1989) found that, to be successful, projects introducing new agroforestry technologies should follow at least the basic established patterns of farming systems research. This pattern starts with diagnostic research at the farm level to identify problems, moves to on-station research to find possible solutions, then to adaptive on-farm research linked to extension, demonstration and adoption. Findings indicated that a failure to follow this pattern leads to a poor "fit" between projects and farmers needs (Cook and Grut, 1989).

Whatever methods ultimately are used to identify relevant agroforestry technologies and initiate trials with the intended users, it is almost certain that the initial technology that is identified can be improved over time (Raintree, 1990). Because of this a special emphasis is placed on the need for an iterative process, or "re-diagnosis" and "re-design," in agroforestry research. Introducing a new technology may, by itself, modify the diagnosed situation and warrant a repeat diagnosis. In addition, no technology that is selected solely through a discussion with the intended users can be regarded as properly evaluated by the intended users until they have had time to live with it on their farms for an adequate trial period (Raintree, 1990).

Scherr (1991) stresses that the several characteristics of agroforestry that complicate the research process, as mentioned earlier, tend to make on-farm research unusually important in agroforestry research. Indeed, *Agroforestry Systems* (1991) devoted an entire issue to discussing this topic due to its relative importance to the development and improvement of agroforestry technologies and systems.

In her discussion of on-farm research for agroforestry, Scherr (1991) highlights five important components of the agroforestry research agenda, all emphasizing studies undertaken on-farm, or in close interaction with farming communities:

1) diagnostic studies to determine the potential relevance and use of agroforestry systems for specific farming systems;

2) studies to document basic information about trees and shrubs used in agroforestry;

3) strategic studies on basic processes of agroforestry response and interactions[3];

4) design and testing of agroforestry technologies with farmers, to assess the technologies' development potential for specific farming systems (participatory research);

5) studies of changing patterns of agroforestry in land use and policies to effectively support farmer adoption of agroforestry.

Scherr (1991) adds that, as in D&D, these complementary components of research should ideally run in parallel, with close linkages and integration to allow for an "iterative re-diagnosis and redesign" based on new findings.

2.3 On-station and On-farm Research Linkages

> "On-farm research (OFR) is a problem-oriented approach to agricultural research that begins by diagnosing the conditions, practices, and problems of particular groups of farmers. Once the problems are identified, a research program is designed to address them. A key part of any such program is conducting experiments on farmers' fields under farmers' conditions and management. Those experiments are then evaluated using criteria that are important to the farmer, and the results are used to make recommendations." (Tripp and Woolley 1989).

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[3] Due to the system complexity and variability found in agroforestry, such systems present greater challenges for research design and implementation. "Strategic" in this sense means that scientists must move cautiously into committing resources for long-term agroforestry experiments. Each experiment needs to be designed to meet priority research objectives for a well-defined research domain (Scherr, 1991).

Despite a recognition for the need to conduct experiments under "farmers' conditions and management," on-farm research most commonly seeks to validate and demonstrate technologies developed under controlled experimental conditions (Sumberg and Okali, 1988; Francis and Attah-Krah, 1989). Sumberg and Okali (1988) argue that on-farm research has a role in all stages of technology development, but objectives and methodologies transplanted from the research station are inappropriate, particularly given the restrictions they impose on farmers' capacity to experiment with new technologies.

Before agroforestry technologies can be taken to the farmer, even on an experimental basis, questions pertaining to appropriate tree species, and reliable, economical establishment methods must be addressed (Sumberg and Okali, 1988). Inevitably, new research questions will arise from the experiences of farmers that may most appropriately be explored in highly controlled research plots (Collinson, 1987). It is this dynamic and iterative interplay between a well balanced mix of on-station and on-farm research that can help realize the potential of on-farm research for agroforestry (Sumberg and Okali, 1989; Kerkhoff, 1990; Scherr 1991). Scherr (1991) emphasizes that this dynamic interaction must be continuous and not sequential. Regular farmer visits to station trials will enhance early feedback on technologies under testing before trials are attempted in farmers' fields (Pinners and Balasubramanian, 1991).

According to Kerkhof (1990), the question of the relative merits of "on-station" and "on-farm" research is still hotly debated in agroforestry circles. It is very difficult to design trials that provide statistically valid results, while at the same time reflect the complexity and variability of local farming conditions. The only way around this problem seems to be a combination of both on-farm and on-station trials (Kerkhof, 1990).

Flora (1992) notes that before a technology is developed and tested the challenge for farming systems research is to determine what is crucial about the environment before a technology can be, 1) effective (often based on agroecological variables) and, 2) adopted (often based on socioeconomic variables). The constant challenge is to determine quickly and parsimoniously the key differentiating characteristics in each situation that will allow the development of the best technology most likely to be adopted to meet the needs of the farm family (Flora, 1992).

The following two sections discuss some methods and considerations for acquiring needed information (both socioeconomic and biophysical) for agroforestry technology development and on-farm research.

2.4 Diagnosis: Assessing Knowledge, Constraints and Needs for On-farm Research

Tripp (1991) describes the following problems as seemingly endemic to on-farm research. First, although on-farm research was developed to address the needs of resource-poor farmers, defining client groups has been a major problem. This in itself is not surprising, as Rölings (1988) notes that targeting research and extension towards resource-poor farmers has always been difficult. However, even when researchers may be able to describe farming practices in the area, they often locate trials on unrepresentative fields, often producing results of little relevance to the majority of farmers (Tripp, 1991b). Second, poor diagnosis is often a problem. Extensive formal surveys, covering every facet of a farming system, have been a feature of many on-farm research projects. Often, however, there is little connection between the data generated and the research priorities that eventually emerge (Flora 1992; Tripp, 1991b).

Tripp and Byerlee (1988) make several suggestions, based on past experience, that would allow the social scientist to play a more effective role in on-farm research. To be effective, social science research methods need to be flexible, relatively simple, well focused and rapid. Effective participation (of farmers) in diagnostic activities for applied research requires timely results for planning experiments, and informal but well-focused surveys are best suited to meet that need (Tripp and Byerlee, 1988).

In very general terms, surveys can be separated into two types: informal and formal (or structured). Simply put, an informal survey begins with conversations with farmers (or other informants), based on an initial set of guidelines or hypotheses, and centers on questions or topics which are of interest to a researcher or program. As information is gathered, other topics or concerns that arise out of conversation are pursued. Results are then written up and should be used for project planning (Tripp, 1991a). As Tripp (1991a) notes, "informal" is perhaps a misnomer, especially if it gives an impression that surveying is done in a casual or haphazard manner. Considerable experience is usually required to plan and carry out an informal survey (Tripp, 1991a). Informal surveys are often followed up by formal surveys, although this need not be the case if informal surveys are implemented carefully. (Tripp, 1991a&b).

A formal survey, which uses a structured questionnaire, is nevertheless useful for a variety of reasons: 1) it provides good baseline data against which progress of adaptive research can be measured; 2) it presents the opportunity to quantify the most common practices in an area and to form a more precise idea of what constitutes "typical" or "average" farmer practices; 3) the results can provide a better understanding of variations in farming practices; 4) a more precise estimate of farmers' perceptions of production problems can be developed; and 5) if well conducted, formal surveys can contribute to further exploring the causality of production problems, which helps identify problems (Tripp, 1991a).

Kerkhof (1990), after surveying 21 agroforestry projects in Africa, found that well-designed surveys followed by proper monitoring and evaluation are crucial in putting projects on the right track. However, Kerkhof (1990) also found that projects had a tendency to implement elaborate, detailed surveys that risked taking huge quantities of time and effort while yielding few practical results. Such situations infer a need to strike a proper balance between the information needed and the amount of time needed to collect the data. Where resources are limited, the best approach is to keep things simple and focused (Kerkhof, 1990). This means carefully designing a survey that focuses as closely as possible on the issues (biophysical or socioeconomic) most relevant to the project. "It is important that surveys (regardless of what type) are treated as an integral part of the project if they are to provide usable results. Involving extension staff in carrying out surveys, and in analyzing their results, is usually the best way of doing this; it also has a useful staff training function" (Kerkhof, 1990 p.7).

Structured surveys may be important for verifying selected findings of an informal survey, quantifying some important variables, providing a cross-check for the informal survey, and lending greater credibility to a diagnostic exercise (Hildebrand, 1986). Hildebrand (1986), suggests that a formal, structured survey may be replaced by a slightly longer and more carefully managed informal survey than would be otherwise conducted, or by two or more informal surveys. Implementing two or more informal surveys would be most relevant in areas with more than one cropping season, or with distinct seasonal weather patterns if addressing issues farmers face at those different points in time.

Another alternative for diagnosis is the Rapid Rural Appraisal (RRA), which now refers to a wide range of techniques and methods. Several principles illustrate the key features of RRA (Scoones and MacCracken, 1989):

1. Rapid Rural Appraisal comprises a series of choices for any given situation.

2. The process of RRA is iterative. Questions are added or revised by the team as information progressively is revealed

3. A multidisciplinary team is utilized, allowing for a broad spectrum of insights.

4. RRA is semi-structured -- it is systematic while at the same time maintaining flexibility and adaptability.

5. Triangulation is used to achieve accuracy. This involves using diverse methods and information sources rather than statistical replicability.

6. Unnecessary detail is avoided through optimal ignorance.

7. Trade-offs between precision--breadth--depth--timeliness are made explicit through appropriate imprecision.

8. Recognizing that researchers interfere, RRAs attempt to make biases explicit.

9. The process actively seeks out dialogue with local people and attempts to involve local people in the research process and planning. Thus, it is participatory, and as such it is best carried out by and with local people.

RRA is not a substitute for other information gathering techniques. RRAs seek to inform, usually early in a project's development, and can complement more conventional surveys or anthropological techniques. Weaknesses in RRAs may arise if team members fail to appreciate each others' disciplines, if team members insist on rigid control of variables, or the process is allowed to become too open-ended (Butler and Butler, 1987). Nevertheless, when time and person power are limited, RRAs may be a superior alternative to either conventional surveys or anthropological techniques (Gibbs, 1985).

The sondeo (Horton, 1986; Hildebrand, 1981) is one method of RRA. To identify the specific goals, local conditions, and resources available, sondeos usually involve open-ended questions and dialogue with farmers, as opposed to long structured questionnaires. Usually conducted in interdisciplinary teams, a focus on specific topics or hypotheses intensifies as an informal survey progresses and new information is gathered . RRA is not a standardized method. There are a wide range of possible activities that may be utilized, but it attempts to be systematic in order to be replicable (Gibbs, 1985).

Participatory rural assessment (PRA) was developed in response to some of the weaknesses and other criticisms of RRA. PRA is RRA with full participation of the community (Etling and Smith, 1994). PRA is designed to focus on rural communities, systematize rural participation, and help communities establish resource management plans. PRA focuses on natural resource management and involves specialists from various disciplines and organizations (Ford, 1989). Local villagers cooperate actively in each step of PRA. Theoretically these steps include the following: 1) site selection, 2) preliminary visits by the PRA team, 3) collecting data, 4) data synthesis and analysis, 5) ranking problems, 6) ranking opportunities, 7) adopting a village resource management plan, and 8) implementing the plan. Teams are usually composed of four to six specialists (Etling and Smith, 1994). Spatial, temporal, social, and technical data are emphasized in collecting data. Spatial data come from village sketch maps compiled with village leaders, a village transect with land uses, and individual farm sketches (usually six to eight farms). Temporal data include a seasonal calendar depicting land use, food surpluses and shortages, cash availability and shortages, etc., and a time line of events depicting changes in resources (i.e. deforestation, soil loss, rainfall, population). Social data is collected through farm interviews carried out at the households where individual farm sketches are compiled (Etling and Smith, 1994).

Once data is collected, it is organized and lists of problems and opportunities for action are compiled with village representatives. Villagers are then gathered to discuss the listed problems and assign priorities to them, as well as to define and rank opportunities that may address the most severe problems. A written plan is then developed that describes the opportunities to address problems, specific actions to be taken, individuals or groups responsible for various actions, resources needed, and a timeline for completion of activities. A village leader usually guides the implementation of the plan (Etling and Smith, 1994).

The advantages of PRA are numerous: 1) the creation of visual materials that villagers can easily understand; 2) involvement of villagers, village groups, and interested agencies through systematic participation; 3) interactive problem solving and interdisciplinary problem solving; 4) identification of village based priorities; and 5) application in the field quickly and inexpensively (Etling and Smith, 1994). The primary disadvantage of PRA is that it omits evaluation, as it tends to end with implementation. In addition, PRA fails to address the problem of a lack of leadership and program management skills that exist among the farmers. These skills are needed in implementing plans, and the lack of which usually cause greater problems than the lack of resources or technical expertise (Etling and Smith, 1994).

Rocheleau (1991) suggests that researchers need to expand their repertoire of appraisal techniques, to both improve capabilities for participatory research and so that individuals and institutions have a wide range of choices to use within a multiplicity of local and national conditions. Several appraisal methods are listed that can help to describe a particular place and situation and to direct research and development plans to fit rural people's realities, including some of the methods mentioned previously (i.e. Rapid Rural Appraisal, D&D, Agroecosystem Analysis, Participatory Rural Appraisal, Ethnoecology, and syntheses of some or all of these). The danger with any appraisal method is that a single appraisal or survey may not be adequate for long-term planning or may raise expectations and leave residents with what a free "diagnosis" and a prescription for "medicine" that is not locally available (Rocheleau, 1991). There is also the risk that information collected will be used in an "extractive" (as opposed to interactive) manner by researchers[4]. Whatever appraisal method is chosen, to be effective it must lead to action with continuing participation of rural people (Rocheleau, 1991).

There has been too much emphasis on single rapid appraisal techniques to understand priority roles for agroforestry in farming systems (Scherr, 1991). Commonly used appraisal methods were originally intended only as a starting point for researchers to construct a common understanding of a system's problems and identify priority topics requiring further in-depth diagnostic research (Raintree 1987; Scherr, 1991). The iterative process of "re-diagnosis and re-design" emphasized in D&D has often been only emphasized in principle, leaving the initial rapid appraisal as the basis of an entire program of experimental research (Scherr, 1991).

While Scherr (1991) contends that current levels of understanding of the role of agroforestry in land use is still too underdeveloped to be trusted to rapid appraisal alone, she agrees that farmer surveys also are not especially reliable for understanding farmers'

[4] Extractive in this case pertains to the use of information for a reseacher's own information or agenda. Local people may contribute work, knowledge, and other resources, but the information acquired is not necessarily used for the benefit of the people from whom it is collected.

strategies in establishing and managing existing agroforestry systems. Instead, researchers and farmers will have to work together on-farm, in exploratory or "diagnostic" trials with new components, sites, configurations or management systems, to determine jointly which are suitable for more research (Scherr, 1991). Flora (1992) notes that a major recognition of farming systems research in recent years is the iterative nature of diagnosis. Conventional wisdom among practitioners (of farming systems research) now holds that the best diagnosis occurs when working with the farmer or farm family in actual on-farm trials. As Raintree (1990, p.50) asserts " on-farm researchers are, almost be definition, in the community for the purpose of acquiring information." In addition to initial appraisals, several years of on-farm diagnostic research may be needed before investment in long-term formal experiments can be justified, or the specifics of experimental design be appropriately selected (Scherr, 1991).

Nevertheless, whether sooner or later, experimental concerns for both long-term and participatory experiments in agroforestry must be considered. The following section discusses some of these experimental concerns.

2.5 Experimental Concerns in On-farm Research

Rocheleau (1991) notes that much of the literature on on-farm research discusses methods of reconciling statistically valid experimental designs with field conditions. The most frequently used methods are those that allow for control plots, some variation in treatment, and statistical analysis of variable performance by different treatments within or between farms.

In some concluding observations from *Farmer First*, Chambers et al (1989) comment that almost all the on-farm experiments described within their book were designed to produce statistical data in some form. They indicate that there is a need for on-farm numerical (statistical) results that can be used by other agricultural institutions, but that many people would agree that the most important indicator in evaluating new technologies is farmers' adoption. Where other statistical results are needed, the analytical rigor required differs according to whether the analysis is to help farmers or to help the experiment station. Where the primary purpose of analysis is to help the farmer, "techniques in experimental design and analysis which were thought not to be very relevant or helpful (in on-farm research) included standard randomized block designs, Latin squares, and factorial and multiple treatment structure with analysis of variance. In contrast, some techniques found useful to farmers' understanding include scatter diagrams for presenting results from a number of farms, and linear regression, for investigation into the stability of biological systems" (Chambers, et al, 1989, p 159).

In a survey of on-farm research, it was found that common weaknesses in the research process included unanticipated high variability between farmers' management practices, insufficient participation of the farmers, and loss of farms from the study. Successful trials were simple, with few treatments and close interaction with farmers coupled with a flexible design and assessment (Lightfoot and Barker, 1988).

Rocheleau (1991) notes that farmer and researcher preferences for different designs may differ substantially. Just as outside researchers can gain substantial information by varying treatment between farms, farmers may gain and share more insights by having controls and a range of experiments to compare close-up. Farmers may not appreciate the placement of various treatments within a randomized block design, especially agroforestry treatments that cannot be divided into small portions of a cropped plot (Rocheleau, 1991). Additionally, standard statistical approaches do not overcome the problems of high levels of within and between farm variation often encountered in on-farm trials.

Nothing can substitute for knowledge about levels of variability in trial sites (Pinney 1991). Pinney (1991) suggests that since neither a researcher controlled, transfer of technology approach, nor farmer controlled experimentation seem satisfactory for agroforestry; a clear need exists for joint researcher-farmer trials to answer certain types of questions.

To link farmers' research interests in their own land-use system with more formal on-farm testing procedures, Ashby (1986) used "the decision-making approach." Under this approach the essential features of a technology are communicated to farmers who are considered both innovative and representative of a wide range of socio-economic levels. Farmers then teach researchers about existing local practices relevant to the proposed technology, enabling researchers to lead discussions with farmers about possible treatments or innovations. From common elements of various farmers' ideas, the researcher designs treatments to be tested. Rocheleau (1991) contends that group-focused farm trials that combine different real-scale treatments on various members' farms with regular group meetings to observe and compare all treatments in the multi-farm experiment provide another alternative to more formal on-farm testing procedures.

The approach of using farmer groups to define on-farm trial treatments is now being used by many projects (Pinney, 1991). However, some researchers are reluctant to involve farmers in trial design and management that stems from an inaccurate view (by researchers) of the rigidity of statistical analysis. As one possibility, Pinney suggests the use of farmer augmented trials to overcome the potential problem of alienating individual farmer innovation in trials. In augmented trials, farmers gain familiarity and experience with a technology and then suggest amendments to on-farm experimentation. Augmented trials contain both treatments that are replicated in every block and those that are not. For the researcher who must still meet the requirements of a more rigorous scientific analysis, the existence of statistical computer packages ensures that most trials have complete blocks and equal replication of all treatments by removing conservative computational design restrictions of orthoginality and balance. "Designs that are not balanced but constructed to make pair-wise treatment occurrences as possible, achieve little variation in the precision of treatment differences from balanced designs" (Pinney, 1991 p.264).

Thus, still retaining some structure for analysis, on-farm research under this design enables more flexibility and participation from farmers while enabling researchers to conduct scientific comparisons.

2.6 On-farm research and farmer participation

On-farm and farming systems research literature has traditionally placed a strong emphasis on farmer participation and collaboration and on talking to farmers about their needs, problems, and reactions to technologies (Biggs, 1989; Cernea et al. 1985). As Rocheleau (1991) notes, however, participation is subject to a broad range of interpretation.

The International Service for National Agricultural Research (ISNAR) uses the term on-farm, client-oriented research (OFCOR) to define an on-farm research approach to help meet the needs of specific clients, most often resource-poor farmers. OFCOR complements and is dependent upon experiment station research. It involves a specific research approach and methods involving a client-oriented philosophy. A series of activities are carried out at the farm level that range from diagnosing and ranking problems through the design, development, adaptation, and evaluation of appropriate technological solutions. Farmers can be directly involved at various stages in the process, i.e. planning, designing, managing, monitoring and evaluation (Merrill-Sands and McAllister, 1988). In a study of nine national agricultural research systems (NARS) worldwide, however, it was found that no one strategy was used to incorporate farmer participation in the research process (Merrill-Sands and McAllister, 1988; Biggs, 1989). This suggests that there is no one "recipe" for eliciting the participation of farmers. Rocheleau et al. (1989) note that the possible types of participation and collaboration on agroforestry trials range from researcher-designed trials on-station to rural peoples' own experiments that are "discovered" and documented by research institutions.

Biggs (1989) defines four types of farmer participation in on-farm research which he utilizes as a framework for understanding farmer participation in an additional study of the same nine national agricultural systems cited above. The modes are distinguished by differences in objectives and the organizational and managerial arrangements required for implementation (Table 1).

In the contractual mode the involvement of farmers is minimal. They provide the resources such as land and labor, that scientists need for on-farm research. This was found, to a varying degree, in all of Bigg's case studies. The consultative mode is characterized by a sequence of research stages: diagnosis, design, technology development, testing, verification of trials, and diffusion of technologies. Farmers are interviewed about their problems at the start, after which scientists accord priorities to the problems, make most of the decisions about what trials will be conducted, and design trials and surveys. Farmers involvement increases again towards the end of the research process when they are asked to evaluate new technologies. This is the dominant mode found in most studies (Biggs, 1989; Ashby, 1991).

The collaborative mode involves continuous interaction between researchers and farmers, who are seen as partners in the research process. Emphasis is on treating farmer participation as a monitoring function to help plan on-farm and on-station research each year. Diagnosis and evaluation are conducted continuously with farmers, not only at the beginning or end of a project. Maurya, et al (1988) used this method as farmers in one on-farm research project were brought to the research station to select, with scientists, rice varieties which scientists then experimented with on farmers' farms. In this mode, scientists recognize that indigenous knowledge is always changing, partly as a result of farmers' informal research and development (R&D) systems, and as such it requires that scientists and farmers constantly exchange new information and insights (Biggs 1989).

Finally, the collegial mode emphasizes activities that are designed to increase the ability of the informal research systems (i.e. farmers) to do research and of informal systems to request information and services from formal ones. The informal and formal research systems act as "complementary colleagues." Research-minded farmers have control over the research site, while scientists serve as periodic guests. The collegial mode is incorporated into few programs in its entirety, and is found in isolated cases (i.e. working with only a few selected farmers) within a projects' framework (Biggs, 1989). The collegial mode is the closest to the Farmer-first-and-last (FFL) approach prescribed by Chambers (1989) as being more cost effective and suitable to resource-poor farmers. While viewed as perhaps an extreme in participatory research, in FFL the main objective is to empower farmers to learn, adapt and improve. Analysis is not conducted by outsiders but rather by farmers or farmers assisted by outsiders. In the FFL approach, if outside support weakens, either financially or by high turnovers of researchers, farmers may carry on. Continuity is in the hands of the farmers and, it is argued, the sustainability of the project becomes more likely (Chambers, 1989).

Table 2.

Types of Farmer Participation

Mode	Objective
Contractual:	Scientists contract with farmers to provide land or services
Consultative:	Scientists consult farmers about their problems and then develop solutions
Collaborative:	Scientists and farmers collaborate as partners in the research process
Collegial:	Scientists work to strengthen farmers' informal research and development systems in rural areas

Source: Biggs, 1989.

Rocheleau's (1991) list is more expansive than Bigg's. She compiled the following typology of different types of collaborative arrangements for agroforestry trials between informal (local) science and practice and "the scientific establishment" (Rocheleau 1991, p.122):

> (1) Researcher-designed and managed trials, (usually on station or special plots).
>
> (2) Researcher-designed and managed trials, on site (farm), in local peoples' work and production sites.
>
> (3) Researcher-designed and user-managed trials, on site.
>
> (4) Joint design and management of on-site trials by researcher and land users.
>
> (5) Trials designed and managed by land users, with outside researcher(s) consulting.
>
> (6) Trials designed and managed by land users. Outside researchers observe and document existing trials, experiments and on-going innovation and may also produce documents for local review, revision and use.

The choice of trial types above, and thus the amount of farmer participation, depends on the type of research question, the variability of social, economic and ecological conditions in the region, and the time, space and precision required to produce useful answers to the questions at hand (Rocheleau, 1991).

The main debate around farmer's participation in research relates to the type of technical changes that can be pursued by farmers and researchers together and how fast technologies can diffuse (Borel and Romero, 1991). Borel and Romero (1991) claim that any project is faced with two basic options in selecting research priorities. The first is for researchers to propose from the beginning (after some appraisal) some alternatives that may appeal to the population. The second option is to start organizing people for participatory research planning (including them in diagnosis, planning and design) without giving prior reference to specific technical changes that could be pursued. Borel and Romero (1991) used the first option in implementing a silvopastoral program in Costa

Rica primarily because the benefits of more decisive farmer participation were not clearly understood at the time. This was partly a consequence of the project being managed by foresters and agronomists, with little input from socio-economic disciplines. Additionally, project planning (i.e. grant) requirements in this instance demanded that the proponents show evidence of working hypotheses, present a detailed time-table of the main activities and present a rough description of the main experiments - all requirements that decrease the possibility of farmer involvement at the design stage. The authors admit that it has taken a long time for the project to reach its current level of farmer participation. To increase farmer involvement at the design stage, it is suggested that a pre-project activity is necessary where the principal activities are to organize farmers and design the main project with farmer input before preparation of formal planning requirements (Borel and Romero, 1991).

Ashby (1991) suggests that the greater degree to which an on-farm research effort emphasizes the role of farmers as adapters of technology (versus adopters) the more participatory the research style will be. A study conducted on the adoption of a diffuse light storage technology in Peru found that farmers did not indiscriminately accept technicians judgments, and few of them attempted to make all improvements at one time (Rhoades et al., 1991). Farmers preferred to make alterations slowly, as they began to understand the principles of the technology involved and as they saw the success of their neighbors. Not dissimilar to the iterative process, this illustrates the need for an evolutionary capacity to be built into technology development (Rhoades et al., 1991). "Technology adaptation by farmers can be merely observed and tolerated as incidental to the mainstream on-farm research effort, or it can be stimulated and integrated into this research process" (Ashby, 1991 p.273).

Gender issues

Sharma et al (1992) note that in many geographic areas around the world, women and children collect most of the household's fuelwood and fodder. Women are an important source of information regarding forest products, the properties of plants that produce them and traditional methods of forest management. As a result of the division of labor by gender, women have different needs and interests in forestry that have not been adequately reflected in project planning (Sharma et al, 1992).

The need to consider women's roles early in project planning and to actively encourage their participation has been noted in several discussions elsewhere (Axinn, N. 1988; Shiva, 1988; Rocheleau, 1985; Fortmann and Nabane, 1992). Nevertheless, Axinn (N., 1988) cites several assumptions and factors that, historically have led to the neglect of incorporating women into agricultural development. First, women tend to be involved in both agriculture and business and are generally noted as working more than men. They may simply not have the time to formally participate in experiments. One factor that may contribute to this is the arrangement of meetings or farm visits at an inappropriate time of day for most women to attend. Second, where researchers are male, a male-on male bias is often encountered. Third, even if a woman desires to participate in experiments it may not be culturally acceptable to interact with male researchers. Thus, depending on the circumstance, special consideration and procedures may be needed to identify and solicit the cooperation of women farm managers for on-farm research.

2.7 Selection of On-farm Research Cooperators

As noted previously, Lightfoot and Barker (1988) found that common weaknesses in the on-farm research process included unanticipated high variability between farmers' management practices, insufficient participation of the farmers and loss of farms from the study. To enhance the participation of farmers in trials, Beer (1991) emphasizes the importance of the selection criteria for farmer collaborators and sites on-farm. He contends that the highest probability of success and impact of long-term collaborative (agroforestry) trials is obtained by selecting innovative, experienced, motivated and locally respected farmers. In implementing on-farm agroforestry research in Costa Rica (Beer, 1991), the project initially sought out the most favorable sites, selecting farmers (still within the target group) with whom there was a high probability of establishing well managed and reliable experiments. The project's rationale for this was that once the staff of the project gained experience with the technologies they wanted to promote, a more representative group of farmers could then be selected and "the remaining problems that occur when introducing a new technology (principally socio-economic) can be faced." Ashby (1986) concurs that cooperators should be innovative farmers, but she also adds that an attempt should be made to represent a wide range of socio-economic resources.

The Costa Rican project noted above sought out innovative farmers. However, this same desire to work with innovative, dedicated, and interested farmers, led an agroforestry project in Northern Zambia to utilize a self selection criterion/process for farmer selection (Holden and Lawrence, 1990). Because selected villages in this project were viewed as having a relatively egalitarian structure, in terms of cash and labor, the farmers selected were considered to be fairly representative of other farmers in the area. However, self selection is not without its own problems. In most instances this process leads to a biased sample of more wealthy or powerful farmers, possibly also resulting in the development of technologies more suited to their resources (Biggs, 1989).

2.8 Research Teams and Collaboration

The previous sections imply a need for a broad range of knowledge and disciplinary backgrounds to successfully develop agroforestry technologies appropriate to the communities or farming systems at hand. The need for multidisciplinary teams for agroforestry research is well accepted, although it is not always a reality due to shortages of trained personnel or financial constraints (Scherr, 1991). Most farming systems or on-farm research programs claim to incorporate a multidisciplinary, effort. However, as Conway (1985) notes, too often, while projects recognize the need for multidisciplinary analyses of agricultural systems, social and biological scientists tend to work separately, only coming together to write some final synthesis of their work. Yet experience suggests that "many, if not most, of the crucial questions for agricultural development lie not in one province or the other, but in their intersection" (Conway, 1985). Gold and Tombaugh (1987) argue that beyond a multidisciplinary approach of FSR, agroforestry research requires an interdisciplinary[5] approach as it depends on forestry, agronomy, horticulture, and animal husbandry as major inputs along with a multitude of other inputs from various sciences. As analysis of the farming system requires intimate and integrated associations of its various components, so should researchers studying those components integrate their knowledge. Not only can this expand the researchers knowledge of his/her colleagues respective fields, giving them a broader view, it enables a research team to work to solve whole system problems rather than just addressing isolated pieces.

In addition to the use of multidisciplinary teams, Scherr (1991) stresses a need for education and training of agroforestry (biophysical) researchers to expose them to a much broader range of both social and technical on-farm research tools and paradigms. From the same standpoint, effective participation of social scientists in a multidisciplinary setting requires that they also have a working knowledge of pertinent technical disciplines (Tripp and Byerlee, 1989; Horton 1986). Some relevant fields are noted: agronomy, soil science, geography, agricultural economics, anthropology, rural sociology, ecology, livestock husbandry, forestry and forest product utilization, rural extension, and communication science (Scherr, 1991). Basic familiarity with methods used in some of these various disciplines, and the scope of disciplinary knowledge, can help researchers select appropriate methods for particular research problems or guide them to the necessary expertise or resources for more in-depth training or advice (Scherr, 1991).

[5] Multidisciplinary research - group research whereby individuals from different disciplines work together on a common problem but with limited interaction. Interdisciplinary research - group research whereby individuals from different disciplines work as a team, with continual intellectual interaction and conceptual synthesis (Roger and Boyd,1982 - p.88).

In instances when a potential shortage of trained personnel, finances, or time exists, nongovernment organizations (NGOs)[6] and formal research and extension services can benefit from closer collaboration (Farrington and Bebbington, 1992; Farrington, 1988b; Dasgupta and Mallick, 1992; Cook and Grut, 1989). The activities of NGOs are community oriented and committed to the empowerment of local communities (Farrington, 1988b; Sagar & Farrington, 1988). More importantly perhaps, NGOs take great pains to remain accountable to their clients because participation of the latter is the justifies their existence (Röling, 1988). This puts them in a position of being able to gain valuable knowledge of local conditions, to assess local needs, and develop integrated research and participatory methods of research. They also can identify strengths and local potential for development and generate valuable feedback to formal research institutions and promote new technologies. In addition, NGOs could benefit from greater access to the technical knowledge at facilities of research institutions (Farrington, 1988; Farrington and Bebbington, 1992). Indigenous NGOs are usually well equipped to mobilize local resources. As such, they generally will be more cost-effective instruments for project implementation. Finally, NGOs are more likely to be able to continue functioning when external resources are withdrawn from a project (Cook and Grut, 1989).

Of course, some NGOs stray from this romantic view, as a wide range of NGO philosophies and approaches exist. Among other things, some NGOs are "top- down," while others can become narrowly tied to government contracts for service delivery. The activities of some NGOs remain uncoordinated, and information exchange is poor, especially among small NGOs where transaction costs are high (Farrington and Bebbington, 1992). In arranging a research collaboration, care should be taken to make sure that the goals of the institutions involved indeed complement one another.

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[6] Farrington (1988) uses the term Private Voluntary Organizations (PVOs) as opposed to NGOs. However, in later work (Farrington and Bebbington, 1992) the same description of PVOs fall under the heading of NGOs. As such, and for simplicity, the term NGO is used here.

Borel and Romero (1991) support increasing collaboration in their review of a CATIE Silvopastoral Project in Costa Rica. They suggest that greater collaboration between development and research institutions could enhance the quality and relevance of agroforestry research because the weaknesses of one could be strengthened by the other. For example, just as development projects or institutions are frequently weak both in staff and equipment, universities and research institutes have difficulties focusing on relevant subjects to farmers and relating to development efforts (Borel and Romero, 1991).

2.9 Evaluating On-farm Research and Agroforestry Interventions

Because of the relative scarcity of scientifically validated biophysical information in agroforestry, monitoring and evaluating agroforestry technologies in development projects plays an important role in the development and improvement of technical extension recommendations (Scherr and Müller, 1991). Scherr and Müller (1991) conducted a review of agroforestry technology monitoring and evaluating in 108 projects worldwide to identify appropriate methodologies. Many of the projects were conducting research to test technologies on-farm or on research plots. Technology evaluation focused on biological performance of trees, often with inadequate consideration given to the socioeconomic context in which the technology would be introduced. Few of the projects appeared to use farmer assessment in evaluation.

The criteria necessary for an effective evaluation when dealing with complex systems, such as agroforestry, or with interventions that are spread out over many years are often contradictory in nature. A challenge faced by many agroforestry projects is how to compromise between the sometimes contradictory requirements of rigorous scientific research on component response and technical questions of immediate value to farmers (Borel and Romero, 1992). It often becomes a matter of pitting "statistical" significance against "practical" significance and risk. The concept of "statistical significance" has been reviewed by Borel and Romero(1991) and Sumberg and Okali (1988). According to

Borel and Romero (1991), when dealing with complex systems such as agroforestry, that spread out the production of products and services over years, farmers' decisions to change their systems is normally based on significant observations, practical differences from the actual situation, and differences that remain fairly constant over time and over various locations. Under these conditions, the standard test for statistical significance becomes a "justification" that the research was well conducted. In other words, statistical significance simply establishes whether or not observed differences between treatments could have occurred even if true average treatment responses were the same. However, the only valid evaluation of "practical" significance of treatment differences is the farmers' acceptance, based on farmers' perceptions of technologies that may or may not coincide with biophysical parameters used to conduct trials (Borel and Romero, 1991). Cook and Grut (1989) agree that the best indicator of success in agroforestry is the extent to which the recommended practices have been adopted by farmers. They conclude that project evaluations should focus on this issue and that local people and local institutions should be involved in all project evaluation efforts (Cook and Grut, 1989).

To illustrate the practical significance of a technology, Sumberg and Okali (1989) were initially discouraged by farmers who disregarded the recommended set of conditions for tree establishment in an alley farming system in Nigeria and planted trees among competitive crops, such as yam and melon , instead of maize. To the surprise of the researchers, trees survived the climbing vines, and although growth was not as rapid as with maize, the trees survived within the local system. Sumberg and Okali realized that, as their objective was to get the trees into the system, it did not matter if it took 6, 9, or 12 months for the trees to become established.

In evaluating agroecosystems in general, Marten (1988, p. 305) attests that "we must also recognize that the ultimate purpose of evaluating agroecosystem performance is to attain better agroecosystems, (where defining "better" is) a process squarely in the domain of value judgments." He argues that our judgment should be concerned with the extent to which agroecosystems are meeting human objectives while avoiding the presumption that one value or another of a system property is inherently good. Researchers tend to assume that higher productivity, stability, and sustainability are better. That may not always be the case. Many researchers also consider greater equitability, autonomy, and solidarity among people to be better (Marten, 1988). The essentially judgmental nature of the persons conducting much evaluation and impact[7] assessment is noted by Koppel (1990), Anderson and Herdt (1990) as well as Marten (1988) above. To do a better job, they contend that investigators of research systems must seek advice from the different actors in the research systems and must be aware of the fact that their informants may "well be biased for all sorts of good human reasons" (Anderson and Herdt, 1990).

Koppel (1990) lists several methods for visualizing linkages between activities and accomplishments in agricultural research, noting that, just as no two research systems are exactly alike, there is no single method of evaluation that fits all systems. The most common type of evaluation, evaluating objectives and actions, starts from the question, "What happened in comparison to objectives?". Within this type of evaluation there are actually many versions and depending on how the question is answered, it is possible to make some judgments about whether a program was a success or not. It is important to note the distinction between two types of objectives - explicit objectives and implicit objectives. Explicit objectives are those that are openly and precisely stated at the outset. Implicit objectives are often not stated openly and may be ambiguous and unclear. Implicit objectives are not there because someone has something to hide; rather they are there to remind us that programs evolve for a variety of reasons (Koppel, 1990). As a result there may be many compromises and trade-offs in the implementation process.

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[7] "Impact" here means "determining the significance, importance, value, or power of an event, idea, etc., to produce changes" (Horton, 1990).

Implicit objectives behind these compromises and trade-offs are often carried into the project, at times becoming more obvious as the project progresses (Koppel, 1990).

A second type of evaluation Koppel (1990) describes as "evaluating the decision-making process." The emphasis is not on outputs and effects alone, but on process--how outputs and effects are achieved. Two different dimensions to this process are noted. The first asks the question, "How similar or dissimilar are the formal or prescribed processes from the informal or actual processes?". Formal and informal decision making usually coexist in projects. In instances where a project contains decision-making arrangements that cross several organizational settings, the project may represent an agreement about how to proceed that can work in general, but will not work for all cases that arise during implementation (Koppel, 1990). Two reasons are given for this. First not every detail and problem of project implementation can be foreseen at the planning stage. Second, agreements that were negotiated when the project started may no longer work because the relationships between those that made the agreements have changed.

The second dimension to evaluating the decision-making process is participation, which directs attention to the actors in programs and projects (Koppel, 1990). Several questions/issues are covered:

1. Who made program decisions?
   - about the allocation of input resources
   - about the transformation of input resources
   - about the distribution of outputs
   - about the achievement of effects.

2. Who benefited?
   - What benefits accrued to those who were the object of the program outputs (according to planning)?
   - To whom did benefits actually accrue?

3. Who paid?
   -Who was supposed to pay? Who was supposed to bear what costs?

A third type of evaluation, evaluation of program levels, is based on the premise that the kinds of activities being evaluated are not all the same. Here building blocks of activities can be grouped into projects which, in turn, make up a program. Objectives are applied to projects, which link together diverse activities. In turn, diverse projects can be linked together to compose a program. In most cases, it will not be proper to apply the same expectations for inputs, outputs, and effects to the program, project, or activity at hand (Koppel, 1990). Which expectations are appropriate at what levels? What are the implications (for a program) of potentially conflicting (project) objectives? For instance, can a participatory activity be expected to operate without difficulty in a nonparticipatory project? If not, what are the stresses on participatory objectives and processes? (Koppel, 1990).

Koppel notes that "this last approach of evaluating by levels begins from this body of interacting objectives and seeks to explore the implications of decisions and actions on some levels for decisions and actions on other levels" (Koppel, 1990).

2.10 Summary

Coupled with on-station research, on-farm research in particular, will conceivably be more integral to the development of effective agroforestry technologies than in any other FSR methodologies. The interaction between on-farm and on-station research should be complementary. This interaction should be continuous, not sequential, to allow for an iterative interplay of research to understand the potential of on-farm research. Additionally, because of the combination of many unknown components in agroforestry, the long-term nature of dealing with perennials in such systems, and the difficulty in direct monitoring and evaluation (i.e. biologically, economically), direct participation of farmers in testing, monitoring and evaluation will be essential for the generation of needed information.

Several factors may facilitate the on-farm research process. Some methods of assessing local knowledge, constraints and needs for on-farm research were noted. Researchers can choose from a wide variety of methods that range from various forms of Rapid Rural Appraisal to longer more detailed surveys. Long , detailed surveys have not been found to be particularly useful to on-farm research, however, due to the large and burdensome quantity of information usually generated and the resulting time its takes to analyze that information. Regardless of the methods ultimately used in gathering information, it is important that the information be made available in a timely manner that allows it to become an integral part of the research program.

Single initial surveys or appraisals should not be utilized as the final word, so to speak, in diagnosing the characteristics, needs and constraints of a community or farming system. Rather, circumstances will change as time passes and as technologies are developed for the farming systems at hand. An iterative process of re-diagnosis and redesign will become crucial. Researchers and farmers will have to work together on-farm in exploratory trials, potentially for several years, to determine what components, sites, and so forth, are suitable to the local system and merit further investment in long-term formal experiments.

Researchers should be aware of the potential experimental concerns in on-farm research: high variability between farmers' management practices and insufficient participation of farmers. Trials should be flexible, simple and with few treatments. Ultimately the trial design will depend upon the level of participation a research program wants to elicit from farmers and whether results from the trials will by used primarily by farmers or research stations and institutions.

Selection of on-farm cooperators is important. Collaborators should be innovative, experienced, motivated and locally respected farmers from the target area.

While researchers should work with enough farmers to allow for farmers dropping out for unforeseen circumstances (i.e. sickness, death, outmigration), collaborators should also be representative of the target community.

The use of interdisciplinary teams is important in understanding both the complexity of agroforestry systems and the context (communities) in which they exist. It is also important that researchers have a basic understanding of the scope of other pertinent disciplines and methods used to guide them to the necessary expertise, should it be needed. However, in instances where a shortage of trained personnel exists collaboration with local institutions (NGOs) should be considered. As an addition to a research program, NGOs often have a long-term commitment in communities that may allow them to generate valuable feedback and promote new technologies, as well as to continue the research of programs that have lost funding and research staff.

2.11 Research Questions

This study reviews an on-farm silvopastoral research program sponsored jointly by Michigan State University and the Jamaican Agricultural Development Foundation. In integrating the research conducted to date on indigenous knowledge, sociocultural and farming systems, and biological and tree fodder systems, an attempt is made to answer several questions:

1) Have the various stages of the MSU/JADF Agroforestry Program met their initial objectives? Why or why not?

2) What was the process that led to selecting cooperators? Were innovative and experienced cattle farmers selected?

3) Are cooperator households representative of the surrounding community with respect to chosen socio-economic characteristics?

4) What was the extent of farmer involvement in trial implementation, i.e. designing, planning, monitoring?

5) Did the various phases of the program build a base of knowledge sufficient enough to meet its major objective: the integration of tree fodder growth and management knowledge with current small-scale farming systems to develop a sustainable small-scale silvopastoral management system?

6) Based on what is already known about on-farm research for agroforestry research, what insights may be gleaned from the various phases of the program that may contribute to improved implementation of similar agroforestry research programs in the future?

Chapter 3

MATERIALS AND METHODS

3.1 Materials

Project research proposals, in addition to theses and presented papers from researchers involved in various phases of the project, were used for information regarding project objectives and implementation. This was supplemented by unstructured interviews with on-farm researchers and persons supervising the project.

The information for descriptive statistical comparisons on the socioeconomic characteristics of the Green Park community and of the on-farm cooperators were derived from secondary data collected for the project from September 1990 - September 1991. Survey responses were put into a spreadsheet package, which in turn was placed into five SPSS statistical package files. This researcher had access to these five files, plus the hard copy describing the associated variables. Data were analyzed using the SPSS statistical package.

The following is a list of formal papers and project proposals from which information was obtained. Table 3 lists all the materials used, inclusive of the list below, to answer the research questions listed on page 35.

Formal Papers

(1) Andreatta, S. 1993. *A Study of Community Formation and Resource Use in a Caribbean Agrarian Resettlement: Green Park, Jamaica (1990-1991) From and Ecological Anthropological Perspective*. Ph.D. Dissertation, Michigan State University, East Lansing, Michigan.

(2) Andreatta, S. and M. McDonough 1992. "Land, Trees and Labor: Developing Alternative Agrosilvopastoral Systems Among Jamaican Small-Scale Farmers." Paper presented at the 4th North American Symposium on Society and Resource Management. May 17-20, 1992 at University of Wisconsin, Madison,WI.

(3) Krecik, Steve 1993. *Fodder Tree Establishment and Production in Seasonally Dry Areas of Jamaica.* M.S. Thesis, Michigan State University, East Lansing, MI.

(4) Krecik, S., D.O. Lantagne, M.A. Gold, and J.M. Roshetko 1994. "Cutting Management of *Leaucaena leucocephala, Calliandra calothyrsus, and Gliricidia sepium* for Fodder Production." Nitrogen Fixing Tree Research Report Vol. 11.

(5) Morikawa, R. 1993. "Fodder Tree Establishment and Utilization in a Seasonally Dry Area of Jamaica." Paper presented at the Fifth Annual Jamaican Agricultural Seminar of the Jamaican Agricultural Research Program (JARP), July 1993, Kingston, Jamaica.

(6) Morrison, B.J. 1991. *Indigenous Knowledge Relating to Fodder Trees and Silvopastoral Management Systems of Small-scale Farmers in Jamaica.* M.S. Thesis, Michigan State University, East Lansing, MI.

(7) Roshetko, J.M. 1991. *Establishment and Nutritive Value of Native and Exotic Fodder Tree Species in Jamaican Pasture Systems.* M.S. Thesis, Michigan State University, East Lansing, MI.

Project Proposals

(8) Phase 1 - Roshetko, J.M, M.A. Gold and D.O. Lantagne "Fodder Tree Establishment In Jamaican Pastures." Submitted October 1989.

(9) Phase 2 - Morrison, B.J. and M.A. Gold "Indigenous Knowledge Relating to Silvopastoral Management Systems of Small Farmers in Jamaica." Submitted October 1989.

(10) Phase 3 - Andreatta, S. and M.H. McDonough "Energy, Trees, Land, Labor and Capital: Developing Alternatives for Silvopastoral Management Systems Among Jamaican Small Farmers." Submitted June 1990.

(10) Phase 4 & 5 - Krecik, S., D.O. Lantagne, and M.A. Gold "Fodder Tree Establishment and Production in a Seasonally Dry Area in Jamaica."

Table 3. Sources of Information for Research Questions

Research Question #	Sources of Information
1	Research proposals, theses/papers and discussion with researchers.
2	Analysis of data from socioeconomic study from phase three. Discussions with the two on-farm researchers.
3	Analysis of socioeconomic data from phase three. Discussion with on-farm researcher from phase four.
4	Discussions with the two on-farm researchers.
5	Integration of project findings from the five phases.
6	Findings from theses/papers. Discussions with the two on-farm researchers. Morikawa's letters/reports to Dr. Gold and Dr. Lantagne from Jamaica.

3.2 Methods

This section addresses the methods used to guide analysis. It is organized by the research questions, and the methods used to answer each question are discussed.

Research Question 1: Have the various stages of the MSU/JADF Agroforestry Program met their initial objectives? Why or why not?

In reviewing project proposals and theses, the following questions guided the analysis:

1) What were the initial objectives of the different phases of research? Explicit objectives were listed in either the proposals or theses.

2) Were objectives altered as research progressed? Why or why not? Some alterations could be found in written papers, some were found in both formal and informal discussions with researchers.

Objectives are discussed, along with a summary of methods used to conduct research in the various phases, under their respective phase headings in Chapter 4. For more in depth coverage of methods used in each phase of research, consult Roshetko (1991), Morrison (1991), Andreatta (1993), Krecik (1993) and Morikawa (1993).

Research Question 2: What was the process that led to selection of cooperators? Were innovative and experienced cattle farmers selected as cooperators?

The researcher implementing the first stage of on-farm research was asked what process he used to recruit cooperators. Determining whether cooperators might be considered innovative or not was more problematic. Initially, analysis of the socioeconomic data from phase three looks at a combination of whether a farmer considers him/herself a full-time farmer, years of experience raising livestock, and willingness to utilize extension. Whether farmers seek out sources of new technology information or participate actively in farm organizations might serve as potential indicators for being innovative. Only a handful of farmers in Green Park, however, belonged to any agricultural organization and only one cooperator did. Ultimately, researchers' perceptions of farmers in the community were also included. Two individuals' (farmers) names came up consistently when researchers were asked questions pertaining to leadership or innovativeness among Green Park farmers, both of whom happened to be cooperators. It is suggested that the individuals "might" be considered as innovative. This should not be considered conclusive, however, as it is based on personal perceptions of three individuals who were not members of the community.

Research Question 3 - What are some of the characteristics of the Green Park community? Are cooperator households representative of the surrounding community with respect to chosen socioeconomic characteristics (i.e. access to resources)?

Analysis of the socioeconomic data collected during phase three initially looks at the Green Park community as a whole, to get a general perspective of where livestock owners stand in terms of relative access to land and other resources. Because the focus of the JADF/MSU Agroforestry Program is on silvopastoral systems, the main focus of the analysis is on livestock (cattle and goat) owners. Comparisons are made between the cooperators of the on-farm research phase and the general population of Green Park to determine if these persons/households might be considered representative of the livestock rearing community and/or whether they might be viewed as innovators in livestock or agricultural production. This was possible because the names of respondents, and thus cooperators, were included in the data set. Several variables were used as indicators. Total number of acres used and their tenure arrangement (whether owned, leased, rented, borrowed, squatted upon or family owned), access to irrigation and use of agricultural inputs such as fertilizer, types of tools owned or used regularly (i.e. a tractor or plow), and the number of cattle and goats owned were variables used to determine relative "wealth" in terms of access to resources. Descriptive statistics generated from the data set are used collectively to show possible characteristics of the Green Park community and farmer cooperators. They are not meant to represent statistically significant findings.

During the analysis of socioeconomic data from phase three, it was decided that having a list of those persons who attended the initial meeting to recruit cooperators for on-farm research might be useful. The researcher from phase five felt that a particular farmer, who arranged this meeting, would have a list of participants. On my behalf, the researcher from phase five faxed a letter to a Peace Corps volunteer in the Green Park area who he shared housing with while in Jamaica and who also knew the farmer. This letter requested the volunteer to ask the farmer for the names of the meeting participants and to send the list of names to the researcher. The list contained the names of 13 individuals all of whose names could be matched to survey responses. This is how the number of women who attended this initial meeting was determined. It is possible that if this list is based on recall alone it is inaccurate. Because the informant is known for keeping track of such matters, however, it is felt that the source is reliable.

Research Question 4 - What was the extent of farmer involvement in on-farm trial implementation, i.e. designing, planning, monitoring, feedback?

Information was gathered from discussions with on-farm researchers from phases four and five. It was not possible to interview the farmers directly. Without feedback from the farmers themselves, it is not possible to determine the farmers' perceptions of how much input they had in the trial process or what they thought of the process at the termination of the program.

Research Question 5 - Did the various phases of the program build a base of knowledge sufficient enough to meet its major objective: the integration of tree fodder growth and management knowledge with current small-scale farming systems to develop a sustainable small-scale silvopastoral management system? Were phases complementary to one another?

In consolidating findings from the various phases, the following questions steered the inquiry:

1) What insights did the various researchers have that might either help or hinder the continuation or expansion of the program (i.e. adding to the base of knowledge for consecutive phases)?

2) Were these insights or recommendations considered in subsequent phases?

3) What other factors might have helped or hindered the attainment of additional knowledge to facilitate the on-farm research process (for instance timing of the phases)?

Research Question 6 - Based on what is already known about on-farm research for agroforestry in general, what further insights may be gleaned from the various phases of the program that may contribute to improved implementation of similar on-farm agroforestry programs in the future?

Interviews with the researchers involved in on-farm research focused on the implementation process itself, seeking information that could not be gathered from theses or other papers. Perceptions of problems and constraints to the research experience were sought out, as well as suggestions as to how researchers felt research could be facilitated in the future. Questions focused on the researchers' perceptions of potential constraints to farmers working with silvopastoral technologies and whether cooperators or other farmers seemed receptive to the technologies. The interview with the researcher from phase five took place within a month and a half of the researcher's return to Michigan State University. A series of questions were used to guide the interview, and these questions are listed in the Appendix. Discussion took place concurrently with a slide show presented by the researcher of the Green Park community and the project. There were points when the researcher answered a question, through a particular slide and the description accompanying it, before the particular question was asked.

A greater emphasis was placed on interviewing the researcher involved in phase five for several reasons. First, he was the most accessible; second because he was the last researcher from the program to work in Jamaica he had access to the most current information on the situation in Green Park. This was important because it was not possible for this study researcher to travel to Jamaica and visit the community or talk to the people living there or participating in the program.

In reviewing the overall program, the approach used here combined aspects from all three of Koppel's (1990) evaluation types. Explicit and implicit objectives were sought. The review did not concern itself with inputs and outputs, as much as with the processes that are used to achieve them. It looked at who made the decisions in project implementation (e.g. design and management of on-farm trials) and who benefited.
By the same token, the various phases were not covered in equal detail. Instead an approach was taken that is similar to Koppel's (1990) evaluation of program levels based on the premise that the kinds of activities being evaluated are not all the same. As noted earlier, activities can be grouped into projects (or phases) which, in turn, make up a program. In most cases it would not be proper to apply the same expectations for inputs, outputs, and effects to the program, project, or activity at hand (Koppel, 1990). Instead, the various phases are covered according to how they contribute to the program as a whole. That is whether they contributed to the base of knowledge that could facilitate further advancement of the program at subsequent levels.

3.3 Organization of Findings & Discussion

The order of Chapter 4 essentially follows the sequence of program phase implementation. In other words on-station trial and indigenous knowledge phases are discussed first, followed by the socioeconomic phase and subsequently by the two on-farm research phases. This sequence gives a perspective as to how the phases unfolded as the program developed. Objectives and methods used to conduct research in the various phases are summarized under their respective phase headings.

In labeling the various sections in Chapter 4, it should be noted that the section titles represent the project phase of the program from which information was gathered. For instance, the section including "Indigenous Knowledge" is not a section about indigenous knowledge *per se*. Rather it covers the methods used and the information and insights gathered from that phase of the program.

In Chapter 5, the research questions for the study are answered. The chapter then elaborates upon some of the other findings, as additional insights and concerns are raised for on-farm research for agroforestry in Jamaica.

Chapter 4

FINDINGS

4.1 Phases One and Two: On-Station Research and Indigenous Knowledge

The initial proposal for the program addressed the first two, concurrent phases of the project: seedling establishment and species trials, and indigenous knowledge. It was anticipated that in establishing proposed baseline "on-station" trials, sites typical of seasonally dry and drought prone areas in Jamaica should be represented. The project's original intent was that more than one site representing a range of ecosystems within the climate type would be established. In addition, it was expected that species identified in the concurrent study on indigenous knowledge of Jamaican silvopastoral management also be incorporated into the species trial (Roshetko et al. 1989; Morrison et al. 1989).

What transpired was different. The intentions for site selection were not met entirely. As mentioned previously, Moneague was selected as the only station site by JADF because of Alcan's Rio Hoe Farms' willingness to lend access to relatively protected land (i.e. from livestock) and resources, facilitating controlled experimental conditions. This site represents an area that, although affected to some extent by seasonal dry periods, has a relatively high amount of rainfall in comparison to Green Park. It is unclear how much of a role climate played in the site selection process. Both Moneague and Green Park were already selected at the time of preliminary visit to Jamaica (Dr. Michael Gold, personal communication).

Table 4 illustrates that climate and biophysical characteristics of these two areas are quite different. Moneague is classified as a subtropical moist forest zone (Holdridge, 1967), at an elevation of 500 meters. Green Park is classified as drought prone with severely disturbed dry limestone vegetation (Kapos, 1986) ranging in elevation from 70 to 232 meters. Moneague has an average annual precipitation of 2,000 mm while Green Park's is 1,140 mm. Seasonal dry spells effect both of these areas, but Green Park may go through periods of up to eight months with less than 100 mm of precipitation.

Table 4. Biophysical Characteristics of Moneague, St Ann Parish and Green Park, Trelawny Parish, Jamaica
(Source: Baker 1968, Holdridge 1967, Kapos 1986 and Roshetko 1991).

	Moneague St. Ann Parish	**Green Park Trelawny Parish**
Elevation	500 meters	70 - 232 meters
Average annual temperature range	15-25°C	18- 33°C (mean: 24-28°C)
Average annual precipitation	2000mm	1140mm (w/ 8months receiving less than 100mm).
Classification	Subtropical moist forest life zone	Severely disturbed dry limestone vegetation
Soil type	St. Ann clay loam (well drained, med. deep clay over rich deposits of bauxite)	95% either Lucky Hill (LH) or Bonny Gate (BG) clay loams - slightly acid to alkaline
Soil nutrient levels	P and K = Low N = adequate	BG - poor nutrient levels, low moisture holding capacity, highly erodible LH - poor nutrient levels, moderate water holding capacity, slightly erodible (ave. soil depth is 12cm. > Bonnygate)
Soil analysis	pH =7.48 Total N = .42%, P = 7 ppm K = 95 ppm	None

In further support of the noted differences between Moneague and Green Park, Andreatta (1993) later found that under Kaiser Bauxite's resettlement scheme, many potential resettlers, given the choice of relocating from St. Ann Parish to Green Park in the 1960s and 1970s, either chose compensation in lieu of property in Green Park, or eventually sold off their lands in Green Park because of this difference in climate. The people of St. Ann could not grow the crops in Green Park that they had become accustomed to in the moister parish of St. Ann.

On-station trials started in March 1990 to test the performance of 22 potential fodder trees under Jamaican conditions. Three trials were conducted. One studied the effects of weed control, fertilization, and planting pit size on survival and growth of direct seeded and seedling transplants of three potential fodder trees (*Calliandra calothyrus, Gliricidia sepium,* and *Leucaena leucocephala*). The objective of the second trial was to identify other fodder tree species, both native and exotic, that may be useful in Jamaica and determine if they could be established by direct sowing. The trial established 15 fodder tree species by direct sowing in an improved grass pasture and evaluated by survival and growth measures 10 months after planting. After the completion of on-station trials, the third trial was conducted at Michigan State University in East Lansing, Michigan where access to the necessary analytical equipment was readily available. This last trial studied the estimated nutritive value of eight native and six exotic Jamaican tree fodder species. Table 5 lists the tree species tested in the three different types of trials at Moneague. Species' selections in trials one and two were initially based on a combination of interest on the part of JADF to test the species, availability of the species in Jamaica, and recommendations from the Nitrogen Fixing Tree Association in Hawaii as being suitable for dry and drought prone areas.

Concurrently with the early phase of on-station trials in Moneague, farmers' indigenous knowledge of fodder and cattle rearing was gathered in Green Park over a four month period. The were three primary objectives of this study: 1) explore small farmers'

Table 5. Fodder Tree SpeciesTested During Phase One (Source: Roshetko, 1991)

Species	Seed/Cutting Source: Local	Seed/Cutting Source: Outside Jamaica
Albizia lebbeck[2]		X
A. procera [2]		X
A.saman[2]	X	X
Bauhinia variegata[2,3]	X	
Brosimum alicastrum[3]	X	
Bursera simaruba[3]	X	
Cajanus cajan[2]		X
Calliandra calothyrsus[1]	X	X
Cecropia peltata[3]	X	
Citharrexylum fruticosum[3]	X	
Chamaecttisus palmensis[3]		X
Desmodium gyroides[2]		X
D. nicaraguense[2]		X
Flemingia macrophylla[2]		X
Gliricidia sepium[1]	X	
Guazuma ulmifolia[3]	X	
Haemaloxylum campechiamum[3]	X	
Ipomoea tiliacea[3,4]		
Leucaena leucocephala [1, 2,]	X	X
Piscidia piscipula[3]	X	
Sesbania grandiflora[2]		X
S. sesban[2]		X

1 Weed control, fertilization, and planting pit size trial at Moneague, St. Ann, Jamaica.

2 Direct seeding trial at Moneague, St. Ann, Jamaica.

3 Nutritive value trial. These species were compared to Jamaican pasture grass species: *Brachiaria mutica, Cynodon plectostachus, Panicum maximum, Pennisetum purpurem* as noted in JLA (1983). Tests were conducted at Michigan State Univesity.

4 An herbaceous vine.

indigenous knowledge relating to fodder trees and silvopastoral management systems; 2) conduct a preliminary investigation of the sociocultural environment of Green Park; 3) examine pastoral land-use systems and technologies in current use. Data gathering combined informal observation and informal topic-focused interviews using a three page interview guide. Through "snowball sampling," where one farmer refers the interviewer to another farmer until all farmers in a study area have been contacted, 40 Green Park resource users were interviewed over a four-month period. Thirty-five of these resource users owned cattle. Findings showed that cattle farmers used several fodder sources in a number of different management systems in their attempts to feed their cattle. Besides improved grasses, tree species mentioned most often were *Guazuma ulmiflolia* (Bacedar), *Samanea saman* (Guango), *Brosimun alicastrum* (Breadnut) and *Gliricidia sepium* (Quickstick). Except for one farmer who planted *Gliricidia*, however, the deliberate planting and use of fodder trees was not apparent. Direct seeding trials on-station included all of these species, but only one (*Gliricidia)* was included in the field trials on-station (refer to Table 5). There were some other species mentioned during this phase that could not be incorporated into the field trials because the research phases ran concurrently and as such, the researcher from phase one did not have the information on these species at the initiation of field trials. Instead, samples of these additional species were gathered in or around Green Park and included in the nutritive (estimating crude protein and mineral content) trial conducted later at Michigan State University (Table 5).

Along with fodder utilization, this study revealed several other things about the community that could effect project implementation. First, Morrison (1991) observed an apparent tension and distrust between some farmers, although he did not pinpoint the exact source of this tension[8].

One possible source of the animosity identified by Morrison was an animosity between some of the farmers and the charcoal burners who, some farmers felt, were the

[8] The exact number of farmers was not noted

cause of much of the degradation taking place in the forests and on hillsides. Charcoal burners were also farmers' primary competitors for a highly regarded fodder tree, *Brosimum alicastrum* (Breadnut). Morrison (1991) suggested that this be further investigated. Andreatta (1993) later revealed that while a certain amount of status and prestige accompanies those that raise cattle in the community, conflicts around cattle entering farmers' fields and destroying crops are not uncommon. Disgruntled farmers have filed formal complaints in some instances. This same type of conflict was noted by Morikawa (personal communication) during his research in phase four.

Morrison (1991) noted, and Andreatta (1993) later concurred, that in addition to certain tensions, community cohesion is lacking in Green Park. Andreatta relates this to the newness of the community as a resettlement area and the lack of developed extended family and formal institutions in the area. Nevertheless, both Morrison (1991) and Morikawa (personal communication) commented that many Green Park farmers who have been in the area long enough to remember, spoke with fondness of the tradition of "morning sport" [9] and of times when farmers in Green Park helped each other. This suggests that some form of friendly and supportive association once may have existed within the community's relatively short history.

Other considerations for project implementation are noted by Morrison (1991). Farmers face difficulties in securing a tractor that may be used to plow rocky, hard soil and make other improvements in cattle paddocks. Generally either farmers must wait to secure a tractor from the Agriculture Department or must rent one from private operators a high rate. Eight farmers had either used or heard of someone else using animal traction. All but two of these eight felt that it was old-fashioned to use animal traction and were uncertain about its viability for their areas. Labor also can be a constraint. Farmers claim that even if they have money to hire, it is often difficult to find people who are reliable and

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[9] Morning sport is the Jamaican term used for a mutual exchange of labor and services whereby a host farmer feeds those who assist him with farm activities (Morrison 1991).

hard working. Beyond simply maintaining cattle and paddocks, these factors make it difficult to improve the quality of cattle rearing.

4.2 Phase 3: Socioeconomic Factors and Farming Systems

Identifying social indicators that might improve or hinder the introduction and adoption of tree fodder production among livestock owners was the purpose of this phase of the program. It was designed to follow-up and augment the study on indigenous knowledge conducted in Green Park. Ideally, information on indigenous knowledge gathered earlier would be integrated with this study's information on livestock production practices, market economics and decision-making practices. Ultimately, the social information gathered would serve as a foundation for an agroecosystem model to develop alternative and sustainable silvopastoral systems (Project proposal for phase three, 1990). With this in mind research three primary objectives were set out for research:

1. Understanding historic and current land use patterns and social factors that describe the system: agricultural crops and livestock; land holdings and tenure; family structure; migration patterns; local organizations; education; technology use.

2. Identifying labor requirements (year round and seasonal) associated with agricultural/livestock management - both family and hired labor, as well as assessing economic ability to hire.

3. Identifying economic factors associated with silvopastoral systems: decision-making processes and markets.

Data were collected in the Green Park community from September 1990-September 1991. Several methods were initially proposed to obtain the needed information. First, the communities would be mapped, locating residences, farm lands, forested/wooded regions, roads, and markets. The maps might include information on livestock practices and orientation to market and subsistence production. This map never materialized. The Alcan Company provided the researcher with a sectional map of the

Green Park community but the researcher did not provide illustration or interpretation of this map that could be incorporated into the rest of the program.

A formal survey would be conducted to identify the characteristics of farmers (man or woman, full-time or part-time), indigenous knowledge pertaining to livestock production, and the farm households' relation to and interaction with markets.
The researcher attempted to interview the entire community using a formal survey questionnaire. Of ninety households identified in Green Park, seventy-one took part in the interviews. The researcher also spent time observing and helping farmers in the fields, and accompanying the local veterinarian on rounds.

Secondary information obtained from various libraries and data banks examined historical agricultural practices in the area. In selected cases, oral histories were collected from selected farmers that examined the agricultural history of the individual.

The purpose of the information gathered during this phase was to facilitate the selection of farmers and identify issues that should be addressed in on-farm research and in the development of sustainable silvopastoral systems (Krecik et al., 1991; Andreatta and McDonough, 1990).

This phase produced a large amount of both quantitative and qualitative data. Some of this data could be added to a baseline of information ifor use in future studies, particularly in Green Park or other Jamaican resettlement communities. Due to the timing of this phase and the next phase, however, most of the information from this study was not available to the on-farm researcher in phase four. Instead, preliminary findings in the form of uninterpreted frequencies, mostly confirming earlier findings from the study on indigenous knowledge, were prepared for the people involved in overseeing the project at MSU.

4.3 Phase Three Continued: Analysis of Socioeconomic Data

This section looks at some of the data collected from Phase Three and sets out to address several questions:

1) What are some general characteristics of Green Park farmers? Of cattle farmers in particular?

2) What resources are available to farmers (i.e. water, fertilizer, land)? What are constraints (as perceived by the farmer) to livestock production that might be considered in developing technologies for silvopastoral systems?

3) Information was not available on the particulars of the Green Park community prior to the selection of cooperators for on-farm research. Without this information in advance, how did the project fare in its selection of farmer cooperators relative to the community as a whole?

4) How do farmers gather new information on farming and cattle rearing? Do they belong to farming associations?

5) Are cooperators representative of the surrounding community? Are women included as cooperators?

6) Are cooperators representative of other cattle farmers in Green Park?

7) Are cooperators experienced cattle farmers?

8) Can cooperators be considered innovative?

For reasons discussed in the following section phase four did not incorporate socioeconomic data from phase three into its agenda. The result was that cooperators for on-farm research were selected without background information on community members.

Table 6 summarizes a few selected characteristics of the Green Park community. Comparisons are made between the entire community. Individuals are also characterized as either female or male respondents, full-time farmers or other primary occupations, cattle farmers, and farmer cooperators.

Table 6. Summary of Selected Characteristics of the Green Park Community

	Age (Min/Max)	Total Acreage Used [1] (Min/Max)	Acreage Owned (Min/Max)	Acreage Leased (Min/Max)	Number of Cattle (Min/Max)	# of Years Rearing Cattle (Min/Max)	Years Living orFarming in GP
Entire community (n=71)	58 (24 / 77)	9.6 (.1 / 74.5)	5.1 (0 / 35)	2.3 (0 / 39.5)	5.5[2] (0 / 30)	16.9	14.9 (0 / 29)
Male respondent (n= 52)	59.3 (25 /77)	10.9	5.3 (0 / 30.8)	2.9 (0 / 39.5)	6.6	19.5 (0 / 70) n=49	15.4
Female respondent (n=19)[3]	54.2 (24 / 72)	6.0	4.6 (0 / 35)	.63 (0 / 8)	1.9	8.94 (0 / 41)	13.5 (1 / 27)
Fulltime[4] farmer (n=32)	63 65 (Cattle)[5]	9.7 13.1 (Cattle)	4.6 6.3 (Cattle)	3.2 4.9 (Cattle)	7.8 7.4 (Cattle)	17.2 24.6 (Cattle)	16.1 16.5 (Cattle)
Other primary occupation (n=39)	53.8 55 (Cattle)	13.6 12.6 (Cattle)	5.6 7.9 (Cattle)	1.5 2 (Cattle)	9.7 9.2 (Cattle)	16.7 21.3 (Cattle)	17.3 15.6 (Cattle)
Male fulltime (n=23)	64.2 (25 / 77)	12 (.7 / 74.5)	5.6 (0 / 18)	4.3 (0 / 39.5)	5.9 (0 / 28)	19.2 (0 / 60)	16.28 (.4 / 29)
Female fulltime (n=9)	59.9 (26 / 72)	4.1 (.3 / 9.5)	2.1 (0 / 8.5)	.44 (0 / 2)	2.1 (0 / 6)	11.63 (0 / 41)	15.6 (2 / 27)
Cattle owner (n=46)	59.3 (25 / 77)	12.9 (.5 / 74.5)[6]	7.2 (0 / 35)	3.3 (0 / 39.5)	8.6 (0 / 30)	22.8 (1 / 70)	16 (0 / 29)
Male cattle (n=40)	59.5 (25 / 77)	13.1 (2 / 74.5)	6.79 (0 / 30.8)	3.8 (0 / 39.5)	8.9 (0 / 30)	23.2 (1 / 70)	15.6 (0 / 29)
Female cattle (n=6)	58 (49 / 72)	10.9 (.5 / 35)	9.3 (.5 / 35)	.57 (0 / 2)	5.8 (3 / 11)	20.3 (11 / 41)	19.6 (14 / 22)
Farmer cooperators (n=5)	59 (46 / 77)	32.4 (11 / 74.5)	11.8 (2 / 30.8)	16.5 (4 / 39.5)	15.4 (4 / 28)	15.6 or 19 (2 / 21)	19.4 or 23.5 (3 / 28)

1 Total acreage is the summation of all land in use by farmers including areas defined as owned, leased, rented , family land, borrowed or squatted in Green Park. It does not include lands held or used outside this area, which for at least five households, exceeds 100 acres.
2 This average includes the five farmer cooperators. If we exclude these households, the number of cattle owned (n=66) drops to 4.7.
3 Number of female resondents varied depending on the file used. The range was 16-19.
4 Fulltime farmers are those who describe farming as their primary occupation. They may or may not have other sources of income through extra seasonal employment, spouse employment, pensions or children.
5 This second number indicates the average of only fulltime/other primary occupation farmers who also raise cattle (n=21).
6 The minimum acreage listed here reflects only the land used in Green Park. In a least one instance, a farmer is listed as using a total of 2 acres of property in Green Park and yet raises 25 head of cattle. This same farmer is known to have access to 131 acres of "family land" outside, but nearby Green Park (Andreatta, 1993). As acreage owned or used outside of Green Park is not included in the data set, use caution in interpreting minimums,maximums, or overall access to resources.

Table 6 does not include land used (owned, leased or otherwise) outside Green Park. At least five farmers are known to have access to over 100 acres in other areas, including a non-cattle owner who raises sugar cane, and a cattle owner (Morrison, 1991). In addition, there is a customary system of freehold tenure called "family land," widespread throughout the Caribbean, that is a form of joint tenure, for all consanguine children, legitimate and illegitimate, of a particular farmer (Blustain, 1981). The data set noted this term, but the term was assigned inconsistently within tenure designations. One farmer in Green Park designated seventeen acres as family land, and another farmer who indicated having access to substantial land holdings (more than 100 acres) outside Green Park designated that same land as family land. However, no questions pertaining to tree tenure or planting on family land are noted, and as such it will not be discussed further than saying that the circumstances around family land should be investigated in the future.

Cattle owners tend to own or have access to more land than non-cattle owners (Table 6). However, cattle farmers who consider farming as their primary occupation have slightly less total acreage, owned land, and head of cattle than cattle farmers who list another primary occupation (referred to as part-time farmers). The exception is leased land. Full-time farmers tend to have more leased land than part-time farmers. A farmer's plots may be adjacent to one another, or spread throughout Green Park. Among cattle farmers specifically, 70% (32) list their plots as spread out, while 30% (14) have plots that are contiguous.

Both full-time and part-time farming households may have additional income generated from a spouse's or child(ren)'s occupation, pensions from Jamaica or abroad, or from children living outside Jamaica. Forty-one percent (19) of cattle farming respondent's have at least one child living abroad (usually in either Canada, England, or the U.S.A.). Three have pensions coming from outside Jamaica, and one still has a wife working in the U.S.A. Thus, 50% of cattle farmers have access income generated by family who have lived or are living abroad.

On average, cattle farmers in Green Park have been rearing cattle for a relatively long time - more than twenty years with a range from 1 to 70 years. The manner in which cattle farmers acquire knowledge about farming and livestock also varies.

Seven (22%) cattle farmers belong to a farm organization, while one farmer used to belong. Six of these are members of the Jamaican Agricultural Society (JAS), while one belongs to both JAS and the Coconut Industry. Activity appears to fluctuate, however. Three farmers said that they are inactive, and only two farmers claim to learn of new farming information from their respective organizations. As Table 7 indicates, overall cattle farmers learn of new technologies from some combination of other Green Park farmers (through conversation or observation) and media (radio, TV., books) - 46% (21); from some combination of self-reliance and/or media - 24% (11); from extension agents (agricultural officer) - 6% (3); or from the farm store - 2% (1). The rest - 22% (10) either claim they do not know how they acquire new information or feel that things (technologies) do not change.

For livestock, the majority - 51% (26) of cattle farmers consult with the local Green Park veterinarian; another 19% (9) consult with Green Park farmers and/or the local veterinarian. The rest, 17% (8), go outside Green Park to either Orange Park or Falmouth.

Most cattle farmers raise some type of crop, whether for market or home or local consumption, with 87% (40) planting in the fall and 62% (29) also planting in the spring. Several farmers raise crops both in and out of Green Park, 20% (9). Thirty-nine (85%) cattle farmers perceive drought as a major problem. While 41% (19) add water to crops, only 4 farmers claim that water rates for irrigation were too high for crops. Since few irrigation systems exist in Green Park (Morikawa, personal communication 1993), it is not entirely clear how farmer's bring water to crops or if this addition is effective.

Table 7. Sources of New Technology Information Cited by Green Park Cattle Farmers

Source of Information	**Number of Cattle Farmers Using Source (n=46)**
Farm organization (e.g. JAS, the Coconut Industry)	4% (2)
Combination of Green Park farmers and media (radio, T.V., books)	46% (21)
Combination of self-reliance and/or media	24% (11)
Extension agents (agricultural officer)	6% (3)
Farm store	2% (1)
Claim they don't know how new information is acquired or feel that things (technologies) do not change.	22% (10)
Consult only with local Green Park veterinarian regarding livestock problems	51% (26)
Consult with other Green Park farmers and/or local veterinarian	19% (9)
Go outside Green Park to either Orange Park or Falmouth	17% (8)

A large number, 59% (27), of farmers also mentioned insect damage as a problem. Farmers noted several other problems in crop production as well. Twelve cattle farmers noted that crop stealing was a problem, but not more than six farmers mentioned any one of these other problems: rats, stones, too much work, and cows invading fields. While only six cattle farmers mentioned cows as a problem in raising crops, this was noted as a major source of friction between cattle and non-cattle farmers (Morrison, 1991 and Morikawa, personal communication 1993).

Only one cattle farmer buys fertilizer. A large number however, 74% (34), do add cow manure or both chicken and cow manure to the soil, with two of these farmers purchasing manure.

Farmers raise cattle for several reasons. The majority, 67% (31), use cattle as an additional source of livelihood, while 23% (10) raise cattle to occupy their time. Two farmers view cattle like money in the bank earning interest--it improves itself over time. Another farmer likes cattle rearing because it is a year-round activity.

Many cattle farmers, 61% (27) feel they could manage more cattle. The major constraint to this is land, with 57% (25) claiming that current pasture land is insufficient, while 41% (18) claim that pasture land is sufficient to meet their current situation. Regardless of the land situation, 78% (36) of farmers view a shortage of grass in the dry season as a problem. The majority (80% (37)) of cattle farmers claim they utilize fodder trees as an additional feed source. However, although most farmers have planted fruit trees either for sale or home consumption at some point, the deliberate inclusion of fodder trees in the farming system is not apparent (also Morrison, 1991).

Tenure is an additional consideration in selecting cooperators and sites for on-farm research. All cattle farmers said they would plant trees on land that they owned. Seventeen (37%) said they would plant trees on leased land, while 10 said they would consult the owner for permission before planting and 24% (11) said they would not plant trees on leased land. On rented land, 19% (9) of cattle farmers said that they would plant trees and that they have planted trees, 11% (5) said that planting trees depends on the terms of the individual agreement, but the majority - 61% (28) said that they would not plant trees on rented land.

Lack of labor does not appear to be a major constraint in rearing cattle according to the data, with only one farmer mentioning this as a problem. Only 13 % (6) cattle farmers hire wage labor on a weekly basis. Seventeen percent (8) hire on an occasional basis or irregularly, while the rest, 70% (32) do not hire. Seven (15%) farmers claim they cannot afford to hire labor while 30% (14) indicate that if they do want to hire labor they have difficulty finding workers and that laborers are not hard working. For the most part, farmers rely on themselves and other members of the family for raising cattle.

Seven cattle farmers said they could not afford to hire labor. However, only 11% (5) said that money (the lack of) is a problem in rearing cattle. It was not clear whether this impeded the management at current levels or the expansion of herds. Morrison (1991) alluded to a potential lack of access to credit as a problem for some farmers. This should be investigated further.

Gender Issues:

Gender comparisons indicate that women are not generally involved in cattle rearing. Of 19 female respondents, 31% (6) of households own cattle. Fifty percent (3) of these respondents are widows, and the other three have husbands. One female from the married group is a retired school teacher whose spouse works on a tour ship outside of Jamaica. The household also has the largest holding of owned land in Green Park. While she makes the management decisions for the household, family members are charged with livestock care. Fifty percent (3) of the female respondents owning cattle decide when to sell cattle, as well as how lands are used. Joint decisions between spouses regarding farm management are also made. Deciding how lands are managed and when to sell cattle lies with both spouses in five and eight of total cattle households, respectively. Three women were among the thirteen farmers attending the initial informational meeting held by Krecik (Morikawa; personal communication from Rupert Brown, 1994)[10]. However, only one woman came to the water trough with her cattle and conversed with other cattle farmers on a regular basis (Krecik, personal communication 1993). The two on-farm researchers agreed with the findings of the data that cattle rearing does not appear to be in the regular domain of women (Krecik and Morikawa, personal communication). Nevertheless, the roles of women can play a major part in the household enterprise. For instance, in one household (a cooperator's) where farming is the major enterprise for both spouses, it is the woman's chicken operation that brings in the most regular income for the family (Morikawa, conversation with the Rupert Brown family regarding the Brown family, 1993).

Farmer Cooperators:

The five farmer cooperators tend to have, on average, more access to total acreage in Green Park, both in owned and leased land, than other cattle farmers (Table 5). They also own more cattle. Two of these farmers each own 28 head of cattle - also the highest number of cattle owned by an individual in Green Park. Except for one farmer, cooperators have raised cattle for 19 years, slightly less than the average, but have lived or farmed in Green Park for more than twenty years - well over the average for cattle owners or other residents. The exception to this is one farmer who is a circular migrant recently (1988) returned from the U.S. While he considers himself a full-time farmer, he had only lived in Green Park for three years at the time of the survey and had experience raising cattle for only two years. All but two of his 14 acres are leased.

Two other cooperators consider themselves part-time farmers. They have primary jobs as a mason and a carpenter, respectively, and neither reside in Green Park. They live 5 to 10 miles away but come into Green Park on a very regular basis. One of these

[10] Mr. Brown arranged this initial meeting. In this instance, Morikawa faxed Mr. Brown in Jamaica, at this researcher's request. Mr. Brown responded with a list of all the participants who attended that meeting.

farmers hires labor for cattle rearing on a several day per week basis. The other cooperators do not hire labor.

Three raise cattle as a source of livelihood, while two see cattle rearing as an investment that improves itself over time. All five claim they can manage more cattle. They also feel that pasture land is sufficient for their current levels of cattle. Three farmers have additional land outside Green Park. Four cooperators say that planting trees on leased land depends on the contract, while one says that his contract does allow for planting. Three cooperators do not receive money from outside Jamaica, one still has a wife in the U.S. and also receives a pension from the U.S., and another receives money from a child(ren) living abroad.

Four farmers claim they use fodder trees as a food supplement in feeding cattle, adding that either they collect fodder or are helped by a son. Cooperators saw initial disadvantages of planting fodder trees quite differently, with two seeing no disadvantage, one claiming that it would take too much additional time, one feeling that the land must be cleared for planting, and one claiming that cattle would eat the trees down before they matured.

Only one cooperator claimed membership in a farming organization and he belonged to two - the Jamaican Agricultural Society (JAS) and the coconut industry. Well respected in the community, this particular farmer is perceived as a leader in the community who experiments in farming (Krecik and Morikawa, personal communications 1993; Andreatta, statement at dissertation defense 1993). He has the largest total acreage in Green Park, although almost 40 acres of this is leased, and he is one of the two farmers who own 28 head of cattle. Both he and his wife are involved in the farm full-time, with his wife's chicken operation bringing in a substantial portion of income to help support the education of six children who also help in the operation (Morikawa, personal communication 1993). After Hurricane Gilbert caused heavy damage throughout Jamaica in 1988, this farmer was one of the first in Green Park to take advantage of the government's program to encourage coconut planting .

One other cooperator is perceived as being both knowledgeable and innovative in farming and cattle raising (Krecik and Morikawa, personal communications 1993). He resides outside of Green Park and is a part-time farmer hiring labor on a regular basis. One cooperator is relatively inexperienced with farming or livestock and is new to the community, having no reputation or linkages built up fully in the Green Park community. Another might be considered "average" among cattle farmers in every way previously discussed (i.e. land holdings, head of cattle, etc.), except age. At 77 years of age at the time of the survey, he was the oldest person interviewed in Green Park.

4.4 Phase Four: On-farm research

In conducting on-farm research, the researcher intended to work with farms and farmers that were represented the broad cross-section of interests and needs of farmers in the Green Park area. The economically disadvantaged sections of the community would receive emphasis. Information forthcoming from the socioeconomic study would be used to help select the farmers meeting these criteria (Proposal for phase three). This, however, did not happen.

About the time of the researcher's departure for Jamaica to begin implementing phase four, some preliminary social data in the form of frequencies of results from the survey were provided to advisors at MSU. No interpretation of this data, however, was included at the time. Much of the problem with acquiring more information in the form of advice or recommendations for continuing research and selecting potential cooperators from the anthropologist was due to the timing of these two phases of research. The reseachers' schedules barely overlapped (approximately one week in Michigan), giving the two researchers involved no time to interact personally for a useful exchange of information and feedback. Dr. Maureen McDonough (personal communication, 1993) indicated that no other information regarding the social data was requested from the researcher or program at this time.

Instead of attempting to select representative members from a broad cross-section of the community or to target farmers from economically disadvantaged sections of the community, a meeting was held at the local community water trough with 14 (3 women) of 46 potential cattle farmer cooperators. This general call to meeting resulted due to a combination of a lack of new information about the community and a sense of urgency felt by the researcher involved to get the trials underway in preparation for the upcoming rains (Krecik, personal communication 1993). By the time of the meeting the researcher already decided what species would be tested based on information from the research conducted during phases one (on-station) in Moneague and two (indigenous knowledge) in Green Park. Subsequently, the researcher described the types of trials to be conducted and asked if any farmers were interested and willing to volunteer some of their land and time to assist in the trials. Six of the farmers responded favorably, although one dropped out early in the process. Thus, farmer "self-selection" was the method of acquiring cooperators (Krecik, personal communication 1993).

With the selection of farmer cooperators in place, on-farm research was structured initially around a combination of the contractual and consultative mode described by Biggs (1989). The contractual mode was especially evident during phase four as the researcher predetermined the trials he would conduct, and the cooperators' farms served mostly as a source for land and labor.

The fourth phase consisted of two trials. The first trial established seven fodder tree species, in fodder tree banks, at five planting sites in Green Park (Krecik, 1993). The researcher selected trial species based on a combination of performance in initial trials on station (the exception being *Erythrina poepiggiana)*, the earlier report from the study on indigenous knowledge relating to tree fodder use (Morrison, 1991), a literature search, and communications with the Nitrogen Fixing Tree Association (NFTA), the Oxford

Forestry Institute, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The study objectives were threefold: 1) to demonstrate the biological feasibility of establishing six selected exotic fodder tree species by direct seeding in Green Park; 2) to demonstrate alternative establishment methods for two of those species, and 3) to demonstrate establishment of an indigenous fodder tree species by seedlings. Table 8 lists the species tested in this phase of on-farm research as well as the types of trials conducted.

All trial sites were previously used for pasture, with four sites dominated by Seymour grass (*Andropogan pertusus)* and one by Guinea grass *(Panicum maximum)*. Planting site characteristics were heterogeneous across sites, varying in soil depth, slope, and aspect in comparison to each other. These characteristics showed little variation within sites (Krecik, 1993).

Performance of direct seeding trials in Green Park was evaluated based on tree height and survival, taken at 6 week intervals over 24 weeks, using a completely randomized design. Trials were replicated on each farm.

Person-hours required for establishing and maintaining each site also were recorded (Krecik, personal communication 1993), although only person-hours for trial establishment are noted. General labor activities included herbicide application, plot and planting pit location, pit establishment, seed pretreatment and sowing, and the acquisition, movement and planting of seedlings and cuttings.

Krecik (1993) notes that survival and height growth in this trial was less than reported for the earlier phase one trial on station in Moneague where the area receives nearly twice the average annual precipitation of Green Park. In this previous trial *Gliricidia, Leucaena, Sesbania,* and *Calliandra* grew two to seven times taller in six months.

Table 8. Fodder Tree SpeciesTested On-farm in Green Park, Trelawny

Species	Variety	Establishment method	Tested in Phase One establishment trials on-station (Moneague)
Brosimum alicastrum	local	seedling	
Cajanus Cajan	ICP 88040	direct seeding	X
Calliandra calothyrsus[1]	NFTA 896	direct seeding	X
	local	seedling	
Erythrina poepiggiana	BLSF 2510	direct seeding	
Gliricidia sepium[1]	NFTA 1	direct seeding	X
	local	cutting	
Leucaena leucocephala [1]	NFTA K636	direct seeding	X
Sesbania sesban	NFTA 874	direct seeding	X

Source: Krecik, 1993

1 Also a continuation of on-station trials at Moneague in a second experiment conducted during this fourth phase.

Overall, growth and survival were found to vary considerably between sites. Greatest overall tree growth was attributed to areas having greater soil fertility and less exposure to the elements, i.e. excessive sun and wind exposure. While the poorest overall growth was attributed to poor soils and high exposure to the elements, the particular cooperator involved in the experiment at this site was also the most prone to neglect the trials. Unlike the other cooperators, he often let his cattle in to the fenced-off trial site to graze (Krecik, personal communication 1993). As the literature suggests, differences in management styles among farmers, such as lack of weeding and protection from cattle, have an equally damaging influence on trial outcome and should be noted. Morikawa (personal communication 1993) had similar problems with this cooperator in the continuation of the trials.

A special note on *Cajanus cajan* is in order. This species showed the best initial survival and growth in the trials, but it also had a high mortality ten months after establishment, due to insect and disease problems. Nevertheless, it is known as a short lived species, and Krecik (1993) suggests that it might be useful for short-term fodder production while other long-lived species are becoming established. From a cultural standpoint, it is unlikely that farmers in Jamaica will utilize this species for fodder. *Cajanus cajan* is a highly valued human food in Jamaica and is a major component in one of Jamaica's national dishes - rice and peas (Morikawa, personal communication 1993). While farmers may plant it for personal consumption, feeding it to livestock, at least in Green Park, might take a lot of persuasion.

As suggested by Andreatta (1992) and Morrison (1991), Krecik found that the introduction of *Calliandra* and *Sesbania* to Green Park is constrained by both the lack of local seed sources and the unfamiliarity of farmers with these species. Given the limited knowledge of these species' performances in Jamaica, the very different conditions under which they were tested previously in Moneague, and the fact that farmers had no idea of the species' potential because they were introduced to it sight unseen, it is questionable whether they should have been introduced during this relatively early and introductory stage in project (on-farm) implementation. As noted earlier, before agroforestry technologies can be taken to the farmer, even on an experimental basis, questions pertaining to appropriate species and reliable, economical establishment methods must be addressed on-station. In the future it may be more fruitful to initially work with fewer species that farmers are familiar with, to accustom them to the idea of systematically including fodder trees into their systems. In the meantime, introduced species could be further tested in a controlled area more representative of Green Park's climate, and farmers could then observe these trials to see if they warrant introduction into their own systems.

The second experiment was conducted in Moneague, as a continuation of the trials established during phase one. This experiment looked at the effects of two cutting frequencies on *Leucaena* and of two cutting heights and frequencies on *Calliandra* and *Gliricidia*. Problems with trial design existed in this project (Krecik, personal communication 1993). These centered on statistical design and a lack of randomization of treatments, and a general lack of experience of the researcher in establishing field trials under a wide range of variable conditions. Some of these problems were overcome through the analysis of data using non-parametric statistical techniques. This illustrates a difficulty that can be encountered in overseas research programs where researchers receiving "hands-on training" do not have ready access to advisors/experts and there is an urgency to get the trial into the ground (for climatic or other reasons) without having any preliminary exposure to the sites (Borel and Romero, 1991). Mistakes are caught after the fact and beyond the point of reestablishing trials. While all three species responded favorably to management in Moneague (Krecik et al, 1993), the influence of cutting frequency on *Calliandra* should be viewed as a guideline for management applications and further study that takes into account other factors, including plant spacing, rainfall, temperature, and solar irradiation.

It is difficult to determine how much interaction existed between the researcher and cooperators in establishing these trials. Morikawa (personal communication) noticed during his later stay in Green Park, that a few of the trials previously established and surrounded by fencing around them were no longer maintained by the farmer(s). Asking one cooperator why he was no longer caring for the plot the farmer replied that the experiments did not belong to him. Instead the plots were viewed as belonging to JADF/MSU. In part, this illustrates that if a farmer has no vested interest in a project, and does not share fully in the management of the trials, it is unlikely that he/she will take the initiative to continue experimentation once the project is gone. Nevertheless, if chance permits, a follow-up should be conducted to investigate the ultimate course of the farmer's action for this plot.

4.6 Phase Five: Further Ventures in On-Farm Research

In the last phase, an attempt was made to build on the work of the past two and a half years. The two primary objectives of research were to evaluate the utilization of fodder trees by beef cattle and to investigate and improve establishment techniques for specific fodder tree species (Morikawa, 1993). The selection of species for trials were narrowed down to two - *Leucaena leucocephala* (both a local and a hybrid variety) and *Brosimum alicastrum* (Breadnut). In addition, observation and trials were continued in Moneague, expanding upon the previous research conducted there during phases one and four. In the previous phase, *Brosimum alicastrum* was included initially in on-farm trials but then soon was abandoned because transplants did not survive on any of the trial plots. Despite this result, its local popularity and interest among farmers in this species as a fodder source warranted its further study in the mind of the researcher (Morrison, 1991; Morikawa, personal communication). The researcher gave several reasons for an emphasis on *Leucaena* in the trials. First, the cooperators unanimously preferred it primarily due to animal preference. Cooperators felt that the value of other species as a protein supplement, i.e. *Sesbania, Cajanus,* and *Gliricidia,* is undermined by its lack of palatability. Second, *Leucaena* is a locally familiar species. Third, it is available locally (Morikawa, personal communication with Dr. Gold 1992).

From a participation standpoint, this phase operated on a consultative mode much more so than in the previous phase. Discussion with cooperators and their interest in *Leucaena* and *Brosimum* were what ultimately led to the researcher's decision to focus on these two species. In addition, where phase three focused primarily on establishment in fodder banks, this phase integrated trials into farmers' working systems, integrating trees with local food crops in many instances.

Four trials were conducted[11]: a feed trial comparing a 100% grass only diet and a 10% Leucaena/90% grass combination; a *Leucaena* establishment trial comparing direct seeding with transplanted seedlings; a Leucaena seed source trial; and a *Brosimum alicastrum* seed viability trial (in containers) (Morikawa, 1993). Establishment trials were planted in cooperators' fields, allowing the farmers to intercrop local food crops. In addition, informal trials involving breadnut in direct seeding in the field as well as nursery production were carried out (Morikawa, personal communication 1993). Randomized complete block designs were used in all trials.

To prepare for the field trials, the researcher secured the use of a tractor and disc plow from a local fruit company, something he notes is a rare item to find during that time of year (September).

Briefly summarized, the establishment and seed trials yielded mixed results. *Brosimum alicastrum* showed high rates of germination, with rates being higher for fresher seed sources. However, *Brosimum* does not provide seed on a regular basis and large quantities of seed can be difficult to find. *Leucaena* showed potential, with a hybrid (K636) exhibiting superior performance to the local variety (Morikawa, 1993). In

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[11] Initially, the establishement trial encompassed six seperate field trial configurations. Two of these six trials,however, had almost no survival (Morikawa, personal communication to Dr. Gold, 1992) and were dropped from the investigation.

addition, the local varieties exhibited an infestation of psyllids and an unidentified caterpillar (Morikawa, personal communication 1993). Moisture availability at planting was a major factor in the success of direct seedings of *Leucaena* (Morikawa, 1993). Transplanted seedlings performed better than direct seedings, but are also more labor intensive (Morikawa, 1993). Additional requirements for labor may be a deterrent to farmers utilizing transplants in the field.

Results from the feed trials were not favorable and alone have the potential of negating positive observations of farmers regarding *Leucaena*. Having little experience with cattle or animal husbandry, the researcher consulted an animal husbandry specialist (Dr. Eric Rugsegger, University of Florida at Gainesville), also conducting research in Jamaica, to gain a better understanding of how to conduct the experiment. Eight beef cattle were donated by three of the cooperators for the trials. The animals were fed two different diets, one of grass only and the other of a 10% *Leucaena* (local) / 90% feed mix. It is not clear why such a small percentage of local *Leaucaena* was included in the mix. All animals were stall fed on one of these two diets for 72 days. Seven of the eight animals lost weight, but it was determined that cattle were fed less than daily caloric requirements. However weight loss was significantly greater in those cattle fed the *Leucaena* mix than those fed grass only. The researcher attributes several possible factors to the results. First, none of the animals were accustomed to stall feeding or to being penned (Morikawa, personal communication). Second, animals fed the mix had only encountered local *Leucaena* at random prior to the experiment and were not used to it as a regular part of their diet. Third, mimosine[12] contents were unknown and may have interfered with animal metabolism. Fourth, the researcher was inexperienced in animal nutrition (Morikawa, 1993). In a later personal communication with Dr. Rueggsegger

[12] In *L. leucocephala* the toxic amino acid mimosine interferes with nutrient absorption, decreasing dry matter, protein, fiber, and mineral digestibility (Jones 1979).

regarding a similar trial with which he was involved, a negative response by cattle to *Leucaena* was indicated as well (Morikawa, personal communication 1993).

In addition to the above factors, the use of a local variety of *Leucaena* for trials is problematic. Successful feed trials elsewhere utilizing *Leucaena* have focused on hybrid varieties. The primary reasons for using hybrids have been a higher protein content in hybrid varieties as opposed to local varieties, the lower mimosine content generally found in hybrids, and hybrid resistance to psyllid infestations (Dr. Michael Gold and Dr. Doug Lantagne, personal communications). At the time of feed trial implementation, communications from the researcher to advisors at Michigan State University indicated the use of *Leucaena*, but not the variety. Advisors assumed that a hybrid was being studied when in fact the local variety was used, primarily because the researcher could access a sufficient amount of forage from local varieties. Hybrid varieties were not used because trial plots were not yet yielding enough forage to feed cattle and the researcher was not aware of the potential negative results in utilizing a local variety (Dr. Doug Lantagne, personal communication). Considering that hybrids also performed better in field trials, hindsight suggests that it would have been better to postpone feed trials until enough forage could be collected from hybrids to conduct the trial.

In most parts of the world, ruminants rarely have problems with the mimosine contained in the foliage because the microbes in the first stomach convert the mimosine to nontoxic substances (Hensleigh and Holaway, 1988). In places where this microbe is not naturally present (i.e. parts of Australia, Papua New Guinea, and a few other countries) *Leucaena* should not be more than 30% of a ruminant's diet, but researchers are introducing the necessary rumen microbe to these areas and Australia reportedly no longer has this problem. Ruminants elsewhere (India, Indonesia, Hawaii) have done well on 100% *Leucaena* diets (Hensleigh and Holaway, 1987). More research should be conducted to determine whether cattle in this area of Jamaica carry the necessary microbe for conversion of mimosine and to determine whether a relationship exists between varying levels of hybrid *Leucaena* in cattle diets and a positive or negative response in cattle.

There were other incidents that effected the overall flow of this final phase of the program. First, JADF hesitated in releasing money to hire labor to build fences for protecting crops and for corrals used for the feed trials. The reason given by JADF, among other things, was that they felt the researcher paid more than the going rate for labor in the area and could make due with less money. The researcher also had trouble securing money to buy equipment and supplies for implementing the experiment. In addition, JADF promised to supply a truck to use on a regular basis for transporting fodder from the field to the stalls, but this was never forthcoming. As a result, the researcher spent a large proportion of time trying to secure regular use of a truck for transporting fodder (Morikawa, personal communication 1993).

Despite the difficulties encountered, the researcher did observe several indications of farmers' interest in incorporating fodder trees as an additional feed source for livestock. Three of the cooperators pointed out that for years they cut *Leucaena* out of their pastures and now they intentionally are encouraging its growth as part of the pasture system (Morikawa, personal communication). Other farmers (non-cooperators) requested seed to try in their own fields and deliberately have let *Leucaena* and *Bacedar* grow in their fields. As the researcher harvested *Leucaena* from the roadsides for the feeding trials, a few people asked why he was taking the tree. He explained that he was conducting a trial and the trees served as a source of fodder for cattle. Afterword he noted several occasions of these and other people actively harvesting *Leucaena* (Morikawa, letter to Drs. Gold and Lantagne 1993). This harvesting of *Leucaena* can be looked at from both a positive and a negative standpoint. On the positive side, harvesting indicates that farmers are willing to experiment with new methods of improving cattle rearing. On the negative side, if the feed trials conducted during this phase indicate a negative effect on cattle well-being, similar observations of farmers testing local *Leucaena* on their own could discourage further experimentation with hybrid varieties or other species.

Green Park farmers also inquired about the usefulness of *Leucaena* for feeding pigs and chickens (Morikawa, letter to Drs. Gold and Lantagne 1993). Dried for meal or pellets, *Leucaena* is known as a highly palatable, digestible and nutritious source of food for poultry (Hensleigh and Holaway, 1988). For poultry, a 4-6% *Leucaena* content is recommended. Nonruminants (e.g. sheep or pigs) should not be fed *Leucaena* as major portion of their diet (less than 10%) (Hensleigh and Holaway, 1988). Thus, if enough interest exists in a community, future research might explore the potential for fodder trees as feed sources for other farm animals in Jamaica.

A Note On Goats: The program has only focused on cattle because JADF has a strong preference for working with cattle only (Gold, 1993 personal communication). Although 24 cattle farmers mentioned raising goats (out of 32 total goat herders in Green Park) they also listed praedial larceny as a major constraint to goat rearing (70%). In fact for eight farmers praedial larceny was the primary reason that they quit raising goats. Dogs killing goats, as well as a perception of the dry season as being "hard on goats" were listed by eight farmers as additional constraints. It is not clear whether the difficulty during the dry season may be due to a lack of food, water, or disease endemic to the time of year.

Farmers raise goats because, among other things, they receive a quicker return on their investment than from raising cattle. The constraints listed above, in part, are due to the inability to keep goats corralled in a manner that allows farmers to watch over them more carefully. A few farmers suggested that they would be interested in finding a way to feed goats in a corralled situation. Goats also are generally known to eat and assimilate more types of fodder than cattle. With these things in mind, it may be fruitful to consider goats in the development of a silvopastoral program in the future.

At this point the MSU/JADF Agroforestry Program ended due to funding problems encountered by JADF. Pending available funding, a desire existed to continue and expand on-farm research, as well as conduct further feed trials in order to better understand the reasons for cattle weight loss in the earlier trial and to test the effects of different fodder species on cattle.

4.7 Summary

The JADF/MSU Agroforestry Research Program conducted five phases of research from March 1990 to July 1993. The concurrent on-station and indigenous knowledge phases yielded information on the potential for various species of fodder trees in drought prone areas of Jamaica and elicited information from Green Park resource users regarding their knowledge and use of local sources of fodder. The indigenous knowledge study also provided some initial insights into potential constraints to livestock improvement for Green Park cattle farmers as well as raising some concerns that may have an affect on the outcome of program implementation.

The socioeconomic study gathered a substantial amount of information on the history, structure and characteristics of the Green Park community. This study may be used as a baseline for further study either in Green Park or in other resettlement communities in Jamaica. But it did not provide additional useful information in a timely manner to be incorporated into the subsequent on-farm research phase. Most of this had to do with the timing of the different research phases. Nevertheless, the extensive amount of time needed to process and analyze the amount and type of information generated during this phase and the lack of communication between researchers also played a role.

Using a "self selection process," on-farm research worked with five cooperators. Charatersitics of the Green Park cattle farming community and of cooperators are discussed.

The first phase of on-farm research tested seven fodder species, with selection based on the results from the previous on-station and indigenous knowledge research. Research also was continued on the previously established trials from phase one, in Moneague. In on-farm trials, trees did not perform as well as in Moneague, where they receive two times the precipitation as Green Park, and tree growth and survival varied considerably across sites. In addition, the researcher found that the use of species unfamiliar to farmers was constrained due to a lack of a local seed source.

The second phase of on-farm research concentrated on two species of fodder trees for further trials. Working with the same five farmers, feeding trials were initiated along with new trials utilizing *Leucaena leucocephala* and *Brosimum alicastrum*. The planting trials of *Leucaena* yielded mixed results; the negative results incurred during the feeding trials could be harmful to the adoption of *Leucaena* as a fodder species by farmers.

Chapter 5

DISCUSSION

Because of temporal variations, agroforestry research (studies of existing systems and experiments) must be implemented over many years before conclusive results on component or system performance can be established (Scherr, 1991). While the program did not go as far as MSU/JADF might have liked temporally, there are still some observations and lessons that may be gleaned from the experiences encountered thus far. One thing that almost anyone involved with development projects overseas states is that things rarely, if ever, turn out as planned. The MSU/JADF Agroforestry Program is no exception. There were many unforeseen circumstances that hindered the smooth transition of research between phases and that may have been counterproductive to the advancement of the program had it continued.

5.1 A review of the Research Questions

The following summarizes the findings in relation to the research questions set forth earlier.

Research Question 1: Have the various stages of the MSU/JADF Agroforestyr Program met their initial objectives? Why or why not?

For the most part, the various phases accomplished what their individual objectives set forth explicitly. On-station research established a baseline of knowledge on fodder tree establishment for a drought prone area of Jamaica. The study on indigenous knowledge collected information on farmer's indigenous knowledge systems, examined pastoral land-use systems and technologies in use, and conducted a preliminary investigation of the sociocultural environment in Green Park. Since these first two phases ran concurrently, however, there was only enough time to incorporate findings from the indigenous knowledge study into a nutritive trial outside of Jamaica and not into establishment trials for the first phase. Nevertheless, information from the study on indigenous knowledge was a basis for information and species selection for on-farm research (phase four).

Phase three was problematic. Data and observations were collected to accomplish all the objectives, but the information was not interpreted and made available to the program in a useful manner. Some of this was due to the timing of phases, but the amount and type of data collected also required several months of analysis. As the literature suggests, use of extensive formal surveys for diagnoses in on-farm reseach often encounter the problem of gathering so much data that analysis becomes time consuming and also that much of the data gathered are not pertinent to the project. As a result information gathered cannot be incorporated into project planning and design. Thus, the data from phase three were never used to facilitate the adoption of new silvopastoral technologies in Green Park.

Phase four served as a basis for on-farm research in setting up establishment trials under farmers' conditions in Green Park. As the objectives set forth, on-farm research demonstrated the biological feasibility of establishing selected fodder tree species by direct seeding and alternative establishment methods and demonstrated the establishment of an indigenous fodder tree species. Species' performance was variable. Ultimately, this phase did not seek out farmers with a broad cross-section of interests and needs with which to work, as the data necessary to facilitate the selection process were not available.

Phase five investigated and attempted to improve establishment techniques for specific fodder trees. The utilization of fodder trees by cattle was also evaluated. This last objective was not met without difficulty, and the questionable success of the trials (i.e. a negative response of cattle to local *Leucaena*) did not help promote fodder tree use among farmers in Green Park.

Research Question 2: What was the process that led to the selection of cooperators? Were innovative and experienced cattle farmers selected as cooperators?

As noted, cooperators were "self selected" after an informational meeting conducted by the on-farm researcher from phase four. Whether innovative farmers were selected as a result is arguable. One of the cooperators claims membership in two farming organizations and is the only farmer in Green Park who makes such a claim. This, of course is not enough to determine innovativeness. In addition, much reliance has been placed on the views of the various researchers involved in the program. When researchers were asked about farmers who might be considered leaders or innovators in the community, two of the cooperators names have come up consistently. Although these two individuals indeed might be considered innovators, this is by no means absolute because researchers were from outside the community and id not possess enough knowledge of local growers to make such an assessment.

Research Question 3: Are cooperator households representative of the surrounding community with respect to chosen socio-economic characteristics

According to the data, cooperators tend to have greater access to resources (i.e. land, cattle holdings) and have been raising cattle for a greater number of years than other cattle farmers in Green Park.

Research Question 4: What was the extent of farmer involvement in trial implementation, i.e. designing, planning, monitoring?

In terms of designing, planning, and monitoring trials, it appears that little input from cooperators was included, particularly in phase three. The researcher in phase three had decided what species would be included in the trials before talking with farmers, alhtough some of this decision was based on findings from the indigenous knowledge study. The researcher designed the trials and trials were primarily set up in the form of fodder banks. Farmers helped in the selection of trial locations, labor and maintenance. Phase five operated in a consultative mode more so than in the previous phase. Discussions with cooperators and their interest in *Leucaena* and *Brosimum*, ultimately led to the researcher's decision to focus on these two species. In addition, where phase three focused primarily on establishment of fodder banks, phase five integrated trials into farmers' working systems, integrating trees with local food crops in many instances.

Research Question 5: Did the various phases of the program build a base of knowledge sufficient enough to meet its major goal: the integration of tree fodder growth and management knowledge with current small-scale farming systems to develop a sustainable small-scale silvopastoral management system?

The program got off to a good start in establishing some baseline information for further studies of silvopastoral systems for small-scale farming systems in drought prone areas of Jamaica. But there were some problems. Continuing trials in Green Park based on results of trials in Moneague with its different climate and biophysical features is problematic and is discussed further below. The timing of phases did not always facilitate a transfer of information to subsequent phases, particularly between the socioeconomic study (phase three) and the on-farm study (phase four). Fortunately the study on indigenous knowledge did provide some valuable information for the on-farm research component. The problems encountered in phase five could be a disincentive to cooperators or other farmers in Green Park to systematically include fodder trees in their own systems. It is possible, however, that farmers may be willing to allow the fodder trees already growing in their systems to continue growing, instead of cutting them out as they had done previously. Because it is still too early to tell, further investigations should be made.

Research Question 6: Based on what is already known about on-farm research for agroforestry research, what insights may be gleaned from the various phases of the program that may contribute to improved implementation of similar agroforestry research programs in the future?

The following sections discuss other insights from the MSU/JADF Agroforestry Program that should be taken into account and which may contribute to improved implementation of similar agroforestry programs in the future.

5.2 Climate and biophysical variation: On-station and On-farm Sites

The first of these circumstances was the difference in climate and biophysical characteristics between on-station and on-farm research sites. Although MSU had little to say in the initial selection of these sites, it is important to recognize that if an iterative and continuous interchange between the on-station and on-farm research areas is an objective, the on-station site must be representative of the target areas for on-farm trials. This may mean having more than one location for on-station (controlled) trials. In addition, it would be beneficial if the on-station site were proximate to potential on-farm sites. This would facilitate visitations by cooperators and potential cooperators alike, permitting them in advance to see what the prospects are for some of the proposed technologies. This is particularly essential when attempting to introduce into an area species with which farmers are not familiar. In instances where only one researcher is responsible for overseeing both areas, as was the case in phase five of this project, a great deal of time and resources spent in traveling back and forth from the two areas could be better used by expanding on-farm trials and increasing farmer awareness. Indeed, with such limited time and resources the researcher in phase five noted his frustration in working both areas, given the distance of the Moneague site from Green Park (Morikawa, personal communication 1993).

On-station trials were expanded in Moneague, moving from establishment trials in phase one to fodder production trials in phase five, using trials established during phase one as a base with which to work. These trials will be useful in determining the potential performance of fodder trees for areas resembling Moneague's climate and biophysical characterisitcs, but it is doubtful that the information will be pertinent for areas similar to Green Park.

It would be ideal to have two researchers, one working at Moneague and the other at Green Park, with constant collaboration between the two, as well as with farmers. The interaction between on-farm and on-station research should be continuous and dynamic, not sequential (Scherr 1991). Initially it may be wise to assign relatively inexperienced researchers to station trials, where they can (in the case of university students): 1) meet the rigorous requirements of the scientific community through controlled experimental design and replication; 2) familiarize themselves with the technologies at hand; and 3) through collaborations with other researchers and farmers, acquire a better understanding of on-farm research and its constraints as well as methodologies that attempt to deal with those constraints. "Biophysical academic research (e.g. for a higher degree) within existing on-farm technology trials can create management conflicts between students, farmer and project and therefore should be attempted with caution. The involvement of students can be complementary to the main line of work but the activities should be kept separate in most cases" (Beer, 1991 p.239).

The researcher whose focus is on-farm research and farmer collaboration should have a solid foundation in experimental design and know the various limitations in working with a variety of farmers and farming systems. He/she needs to be willing to venture beyond the randomized complete block, split plot, or use of analysis of variance in evaluating technologies initially. Scherr (1991, p. 101) notes that "the added variability introduced by farmer management of trials may draw into question the use or value of statistics, even though that same variability may be one of the most important factors requiring investigation." To reiterate, she suggests that researchers often need to work together with farmers in exploratory or "diagnostic" trials, with new components, sites, configurations or management systems, to determine jointly which are suitable for further research efforts. "Several years of on-farm diagnostic research may be needed before investment in long-term formal experiments can be justified, or the specifics of experimental designs such as selection of treatment factors, non-treatment factors, control plots, and assessment criteria be appropriately selected" (Scherr, 1991).

5.3 Farmer Collaboration

Had the project continued, it is likely that problems would have been encountered with limiting the number of cooperators to only five farmers. Projects need to plan for the need to "discard" farmers and trials due to unexpected factors such as sickness, death, out migration, etc. (Holden and Lawrence, 1990). A farmer drop-out rate of 50% during the life of an on-farm trial is not unexpected, especially in agroforestry trials run for several years (Pinney 1991). At the outset of the trial a contingency for such a drop-out rate should be planned so that enough farms remain to ensure the precision of the treatment estimates and allow for useful inferences to be made.[13] As noted, both on-farm researchers had some difficulties with one of the cooperators for the project. For instance, he tended to neglect the plots by allowing cattle into the research area for grazing. While all the cooperators were self-selected, looking at some of the characteristics of this farmer (a circular migrant, new to the community/area and new to livestock raising and farming in general) it is possible that itnitially he is not the best farmer in the community from which to elicit feedback (in terms of livestock raising) initially.

This is not to say that farmers who do not have years of experience in farming/livestock and innovation should not be included if they desire to participate. On-farm research should include a wide range of farmer types from the target group (Ashby, 1991). However, the selecting motivated, innovative, experienced, and respected farmers is vital during the initiation of on-farm agroforestry research projects (Beer, 1991) because it is important to work with enough farmers that have a background of knowledge and experience with which they (the farmers) can make solid comparisons. As experience suggests, it is important to remember that variability in farmer management will be high when working with a wide range of farmer types, and this may limit the effective use of statistical analysis.

[13] According to Pinney (1991 -p271), if half the farmers drop out with no structure, then an expected increase would occur in the standard error for treatments by a factor of about $\sqrt{2}$.

Cooperators should be actively sought beyond simply meeting with a group, describing the research technologies and asking for volunteers. Such self selection can lead to an unrepresentative group of farmers with which to work (Ewell, 1989). To facilitate this search for innovative farmers, researchers need access to pertinent information to help identify farmers that researchers may want to approach. There needs to be more integration between social and biological researchers to identify potential cooperators. Potential reasons for the a lack of farmer willingness or constraints to participate should be sought out early on, before the initiation of on-farm research. For instance, as the data indicated and Morikawa (personal communication) mentioned, some farmers in Green Park who lease land are unwilling to plant trees for fear that the leasor might see the improvements and reclaim their land when it comes time to renew the contract. Armed with information on which farmers have access to enough land and also indicate a willingness to plant trees on it, a researcher overseeing on-farm trials might directly seek potentially interested farmer cooperators instead of relying on a general call to meeting. In addition, the source of tension exhibited in the community noted by Morrison was never fully pursued. It is still not known whether this hampered the willingness of some farmers to participate in trials.

While secure land tenure is a definite consideration in choosing farmer cooperators to work with in Jamaica, experience in Green Park suggests that proximity of tenured plots in relation to either the homestead or worked farm land should also be taken into account. Three of the five farmers involved in the on-farm trials deliberately placed trials close to currently farmed lots because of proximity to the land that they already frequented and because they had a vested interest in protecting the area from livestock and other external forces. As such, these trials tended to run into fewer maintenance problems than those placed on the other two farmers' lots (Morikawa, personal communication 1993).

Andreatta (1993) suggests that, due to Green Park's nature as a relatively young community without formal social institutions fully developed or a history of collective action, it is atypical of other Jamaican communities. Because Green Park lacks some of the social institutions of traditional communities, i.e. a village school, a church that the majority of community members attend, a ball court, etc., as well as a social framework based on collectivism and extended family ties within Green Park; it does not constitute a "community." To confirm these findings a wider range and variety of communities (e.g. resettlement and non-resettlement) within seasonally dry and drought prone areas should be surveyed. Defining the nature of the community *per se*, would not be the major objective. Rather, such a study might explore whether cattle farmers in similar or different communities within dry and drought prone areas face similar or different concerns and constraints as farmers in Green Park.

A potential problem of the Green Park survey is that it was administered once to individual residents and resource users throughout the year. In other words, not all individuals responded to the survey during the same time of year. It is difficult to ascertain at this point, but it is possible that people have different perceptions of constraints dependent upon the time of year (i.e. rainy or dry season). As Chambers, et al. (1981) note, the perceptions of, as well as the constraints and difficulties farmers face will vary depending on the season. It may be wise to administer surveys separately, or repeat the survey, over two different seasons in order to measure more effectively peoples' perceptions of concerns or constraints at any given time of year.

According to the *Statistical Yearbook of Jamaica* for 1991, the parish of Trelawny has the lowest population density of all the parishes in Jamaica (SIOJ, 1991). It may be that introducing similar technologies into areas with a higher population density will be more (less) beneficial when coupled with different pressures on the resource base (both natural and human). As Nair (1992) notes, the type of agroforestry system found in a particular area is determined, to some extent, by agroecological factors. He adds, however, that several socioeconomic factors, such as human population pressure, availability of labor and proximity to markets, also come into play, resulting in considerable variation among agroforestry systems operating in similar or identical agroclimatic conditions. Otherwise it may be problematic extrapolating results of the community survey and on-farm trials based on an area with isolated constraints and circumstances to other communities in seasonally dry areas of Jamaica.

5.4 Tractor Use and Labor Inputs

The use of a tractor to clear land for planting in on-farm plots should be reviewed. While farmers will attempt to secure a tractor for field work when possible, it is usually quite difficult. Only two farmers mentioned using the tractor as a tool for farming. Because farmers often must work within the constraints of physical labor available to them, the researcher involved in these trials should make a point to work within these constraints as well. Otherwise the number of person-hours it takes to establish and maintain a technology will be misrepresented. In addition, when the time comes to expand trials to other cooperators' farms, interested farmers may expect the availability of such resources for their participation. Indeed, it may be the sole impetus for their participation as one farmer (not a cooperator) showed in phase five. In this instance, the farmer expressed an interest in planting trees when the researcher initially arrived. His farm plot was adjacent to one of the cooperators sites that was in the process of being plowed with the tractor. The researcher had the farmer's field plowed as well, as it was small. He also gave the farmer some seed, although the farmer was never seen planting the seed (Morikawa, personal communication). To be successful, incentives must be consistent.

Both Morrison (1991) and Andreatta (1993) note farmers' reluctance in using animal traction as a potential method of clearing land because it is perceived as "old fashioned." Overcoming the cultural barriers of using animal traction may be difficult, or even impossible, in Green Park. However, Green Park has a history of using animal power, and several farmers mentioned their familiarity with it and with farmers using it in other parts of Jamaica. Re-introducing animal traction in Green Park should be attempted, especially for facilitating the clearing of fields for resource poor farmers who have an even lower chance of accessing a tractor than the relatively resource rich and who may be constrained be labor in improving their sites. JADF has indicated an interest in the utilization of animal traction, and there is also a site in Jamaica for such training (Gold and Lantagne, personal communication 1993). To further encourage its use, field trips to the Jamaican training site might be arranged with local farmers to allow them to see first hand the methods and benefits of animal traction.

Potential restrictions to improving pasture systems imposed by labor (or a lack thereof) should be further investigated. Morrison (1991) indicated that labor constraints are a potential problem, although it was difficult to confirm or negate this finding from the phase three data. Questions regarding labor in the phase three survey focused on perceived constraints in farmers' present systems. It was also noted that survey inquiries were not made regarding whether farmers felt that labor might be a potential problem to systematically incorporating fodder trees into their systems. As Cook and Grut (1989) note, it is difficult for farmers to adopt agroforestry packages that require them to organize and supervise labor to perform new tasks in particular sequences or time intervals. Acquiring, transporting, planting, and caring for seedlings may require more resources and more management skills than the average farmer can spare from subsistence activities (Cook and Grut, 1989). In a survey of agroforestry project experiences in 21 countries in Africa, Kerkhof (1990) found that growing trees is more difficult in dryland farming areas. Growth rates are poorer, survival rates are poorer, and protection of seedlings is more of a problem. The projects found that while farmers are willing to plant some trees, the uptake of seedlings from nurseries was often disappointing. Some projects found that encouraging natural regeneration was more acceptable to farmers than tree planting because it is cheaper and less risky than esatablisheing seddling nurseries

(Kerkhof, 1990). Morikawa (1993) felt that the labor concern might be an issue for Green Park farmers in utilizing transplants of *Leucaena*. Future projects should investigate this further, including a study of economic benefits and costs to systematic inclusion of trees in silvopastoral systems.

5.5 Disciplines, Training, and Communication

Finally, there is a need for better communication between researchers involved in the project. An interdisciplinary versus what turned out to be a multidisciplinary approach would facilitate this. Thus several pertinent disciplines should be involved in studying the community and diagnosing potential constraints or problems in the livestock/farming system because no one person, or discipline, can be expected to know or notice all the intricacies involved in a farming system. Ideally, at least one of the on-farm researchers would be involved in a part of this study of the community in order to familiarize himself/herself with the area and the people, within context (as opposed to trying to visualize unseen faces and locations through discussions with previous researchers stateside). Because this is a silvopastoral program, at least one person involved in the diagnosis should have a solid background in livestock husbandry/nutrition, particularly related to cattle.

As noted earlier by Scherr (1991) a need exists for educating and training agroforestry researchers to expose them to a broader range of on-farm research tools. Researchers familiar with a variety of disciplines can both take responsibility for enlightening other disciplines to issues that they feel are important and can seek out the appropriate sources of information as questions arise. The on-farm researcher must be able to readily identify farmers who might be good cooperators and be able to select farmers from a diversity of socioeconomic backgrounds. As in phases three and four, an on-farm researcher may feel that time is of the essence, especially when working against seasonal constraints. The on-farm researcher also must arm him/herself with enough background to ask the right questions of his/her social science counterpart. Ultimately however, only the person/people involved in collecting and analyzing social data can know the extent of what data or other pertinent information exists and, based on their expertise, can interpret the data and identify what issues are important to the success of project implementation.

Another objective of the JADF/MSU Agroforestry Program, besides studying the potential for silvopastoral systems, was the training of graduate students as future researchers of academic, government, and non-government institutions alike. It is felt that students must be given a chance to go out and learn from their mistakes and successes. Because the use of interdisciplinary teams in research institutions is an increasing phenomenon (i.e. ICRAF, CATIE, IDS, CIMMYT), students wishing to work for these types of institutions must be able to work with people from other disciplines to effectively assess a situation, diagnose potential problems and come up with potential solutions when "solutions" are in order.

5.6 Feedback to and from the Community

The JADF/MSU Agroforestry Program's goal was the improvement of small-scale cattle farming systems. Green Park residents permitted researchers to study the community in order to understand constraints to improving both cattle production and farming systems. In addition, a few farmers donated land and labor for the study of potential agroforestry technologies that might address some of these constraints.

The community was never given feedback, however, on the findings from the various studies. For instance, would community members agree with the findings from the indigenous knowledge study or the socioeconomic study? By the same token, did Green Park farmers find the process used for studying technologies on-farm useful? This lack of feedback, especially from the program to the community, draws into question the sincerity of the program in addressing the concerns of the small-scale cattle farmer in Green Park. Programs like this one need to incorporate the feedback of farmers and community members into project planning and development if the program's ultimate goal is to benefit farmers.

5.7 Conclusions

Flora (1992) looked at projects funded by a variety of sources, including international research centers, major foundations and a number of governments. Findings indicated that the longer the trajectory of funding, the more adaptations that the farming systems could make. Because of temporal variations, agroforestry research (both studies of existing systems and experiments) must be implemented over many years before conclusive results on component or system performance can be established (Scherr, 1991). This is especially so when dealing with species and systems that are not only new to communities, but to a country as well.

In this case, the MSU/JADF Agroforestry Program did not have the luxury of time. In three and a half years of research it is difficult to assess the potential impact that this project may have on the community involved or on the development of silvopastoral systems for dry and drought prone areas of Jamaica. Many questions still remain. Will encouraging and providing *Brosimum alicastrum* planting materials to cattle farmers to actively plant, and not distributing the same to charcoal burners, cause increased resentment between these two groups? Will a loss in cattle weight from feed trials utilizing local *Leucaena* cause farmers to abandon *Leucaena* altogether?
Since the program lasted a relatively short period of time, there was no opportunity to further test technologies and refine or revise research. Ashby (1991) suggests, however, that a few farmers will probably continue to experiment on their own, adapting the technologies to their own systems and needs (but perhaps not for cattle at all).

Over the course of three-and-a-half years, five researchers were given the opportunity to expand their research skills and knowledge. A variety of fodder trees were tested, and several were determined to have potential as an alternative food source for cattle in Jamaica (Roshetko, 1991 and Krecik, 1992). Nevertheless, all of the researchers concur that more research is necessary before making wider recommendations.

A time horizon was initially set at between three and five years, yet it was not possible to foresee the end coming quite so abruptly. Nevertheless, an end was assumed. To utilize resources more efficiently and effectively in the future, projects like this one must plan for an end at the beginning, so to speak. Much of the problem with the JADF/MSU Program centered around the timing of phases. Phases did not coincide in a manner in which the transfer or integration of useful information to subsequent phases could be made in a timely and useful manner. To avoid this in the future, consideration must be given to the timing of different phases of research in the future.

Similar projects should look into integrating the efforts of local institutions (e.g. collaboration with NGOs) into the research process so that these institutions also have an understanding for the basis under which technologies are created. Thus, when a project comes to an end and researchers return to their respective countries or institutions, there is a better chance that someone will be left in the area to carry on.

Chapter 6

RECOMMENDATIONS

6.1 Farmer's Input

It is important to get farmers' feedback on the program and technologies, and to incorporate their suggestions into planning similar projects in the future. Further, other farmers who were given seed or planting stock to experiment with on their own should be sought out for their feedback and suggestions. If possible these interviews should be conducted soon after planting, before details have faded from farmers' minds. Because a review of an agroforestry program like this is not complete without the feedback of the farmers whose problems it has set out to address. As such, this study can not be considered complete.

At no point in the JADF/MSU Agroforestry Program is it indicated that the farmers or community were given a summary, in writing or verbally, of the results of the various phases of research in which they had taken part. To encourage the participation of this, or any other community in future projects, a certain amount of accountability to the people of the community by researchers is in order. Formally recognizing the cooperation of the community involved by presenting the results of their cooperative research endeavor is one way of doing this.

6.2 Further Study

Other communities in seasonally dry and drought prone areas of Jamaica should be studied to see if farmers, especially cattle owners, face similar or different constraints as farmers in Green Park. Research suggests that settlement communities in Jamaica differ from other communities in Jamaica. A sufficient number of communities of both types (i.e. settlement and non-settlement) could be studied to verify if differences do exist, and what, if any, are these differences. Ideally an interdisciplinary team, including on-farm researchers, should be included in the assessment of target communities so that each has a better concept of the others' disciplines and approaches and also an understanding of limitations.

Three-and-a-half years is a short period of time for observing agroforestry trials. Clearly more research is needed, both on-station and on-farm, to test the performance of various fodder tree species for dry and drought prone areas in Jamaica. Further study by an animal husbandry/nutrition expert is necessary to better understand the reasons for the negative response of cattle to *Leaucaena*, in addition to testing the palatability of other species to, and responses of, cattle. One cannot expect farmers to invest the time and money into further planting trials for silvopastoral systems if they feel cattle will not or cannot eat the fodder.

Silvopastoral research in Jamaica should consider incorporating goats and possibly other farm animals, as well as cattle into trials. Farmers have expressed an interest in this. What is not palatable to cattle, may be so to goats (or other animals). It is also possible that by penning goats and feeding them on a cut and carry basis, more palatable and nutritious fodder will be freed up for cattle in pastures. It may be that the major endeavor in such research will be finding an effective way to keep goats penned.

More effort should be made to incorporate the input of farmers into all phases of the research program--diagnosing problems and constraints, designing trials, monitoring, and evaluating. Farmers should feel a vested interest in and have an understanding of the trial process, in order to continue research on their own as well as provide useful feedback to researchers.

APPENDIX

APPENDIX

Guide questions for phase five researcher

1. How representative of socioeconomic conditions (do you feel) are the participants of the on-farm trials in comparison to the rest of the community?

2. Have any extension agents (i.e. from the J. Dept. of Ag.) visited or been involved in the research process? If so, when were they incorporated?

3. (Based on Bruce's and Susan's findings) Were you aware of any possible factionalism in the community, especially among farmers/livestock owners? If so, do you have any ideas as to why this animosity exits?

4. In "recruiting" cooperators, what season did Steve have his meeting with community members? *How many of the potential farmers attended?* Do you feel it possible that some potential participants did not attend due to seasonal factors? Is it possible that some farmers did not attend due to community factionalism?

5. What has your involvement been for the last year?

6. What have farmers' responses been to the technologies? Also did the project actually pay cooperators (i.e. R. Brown) to participate in the on-farm research or, in Brown's case, was he paid because he helped the researchers integrate into the community, etc., etc?

7. How much of farmers' own inputs have been utilized in the on-farm trials (i.e. did the project supply all materials and money for labor, etc.)? If so, will this allow a realistic environment on which to base adoptability/adaptibility?

9. Have other farmers (outside on-farm participants) shown an interest in planting experimental trees? Have you noticed actual planting in other farmers' lots? Has anyone? If so,how have farmers' experimented with or adapted. the new technologies to their own situation(s)? (Steve mentioned he had given some seeds to other farmers, although he did not mention to whom) Did you also distribute seeds/cuttings to other (non trial) farmers?

10. Steve mentioned that he took participants on "field trips" or rather "a" field trip, to see "established"(?) projects/technologies. Were these trips just for participants? Did you also attempt to do this? I know that when I asked you this on a previous occasion you replied that you planned to, but transportation arrangements fell through. Where did you plan to take farmers and why? Do you feel that there should be money budgeted for transportation to facilitate such trips/exchanges of information in the future?

11. Were there any plans to incorporate farmer-designed trials (-Vs- researcher designed)? Was experimentation by farmers encouraged?

12. The project focused on only cattle. (Andreatta's survey showed that while eight cattle farmers stopped raising goats due to larceny, many cattle farmers, as well as non-cattle owners, did raise goats and were interested in finding ways of keeping them fenced in and feeding on a cut and carry basis). Do you think goats should have been incorporated as well--especially since goats tend to respond favorably to a wider variety of fodder sources than cattle? (Gut feeling - I know that you do not have an extensive background in animal husbandry.)

13. How did (if they did) your objectives/goals change as the project progressed? Why/why not?

14. What else would you like to have seen accomplished? Would you do things differently in the future? What additional information about the community do you think would have facilitated your research/ or increased farmers' interest in the technologies?

15. Are there other farmers that you thought would have been good cooperators? Why?

16. Did you keep track of labor requirements i.e. the number of hours it took to establish plots and maintain them?

17. Now that the project is over, do you think any of the trial farmers will continue to experiment with or maintain the plots that the project established? After three years, do you feel the project left any lasting impression?

BIBLIOGRAPHY

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Anderson, J.R. and R.W. Herdt 1990. "Reflections on Impact Assessment." In R.G. Echeverria (ed.) *Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research.* Volume II: Assessing the Impact of Agricultural Research. Proceedings of the ISNAR/Rutgers Agricultural Technology Management Workshop, 6-8 July 1988, Rutgers University, New Jersey, USA.

Andreatta, S. 1993. " A Study of Community Formation and Resource Use in a Caribbean Agrarian Resettlement: Green Park, Jamaica (1990-1991) From and Ecological Anthropological Perspective." Ph.D. Dissertation, Michigan State University, East Lansing, Michigan.

Andreatta, S. 1990. "Agrarian Land Use Transformations and Implications for Small Farmers in Jamaica: A social Forestry Perspective." A proposal for research (unpublished).

Andreatta, S. and M. McDonough 1992. "Land, Trees and Labor: Developing Alternative Agrosilvopastoral Systems Among Jamaican Small-Scale Farmers." Paper presented at the 4th North American Symposium on Society and Resource Management. May 17-20, 1992 at University of Wisconsin, Madison, WI.

Ashby, J.A. 1991. "Adopters and Adapters: The Participation of Farmers in On-Farm Research." In R. Tripp (ed.) *Planned Change in Farming Systems Research: Progress in On-Farm Research.* New York: John Wiley & Sons.

Ashby, J.A. 1986. "Methodology for the Participation of Small Farmers in the Design of On-Farm Trials." *Agricultural Administration* 22: 1-19.

Axinn, G.H. 1988. *Guide on Alternative Extension Approaches.* Rome: FAO.

Axinn, N. 1988. "Gender Related Issues in International Development Assistance for Agriculture and Rural Life." *Agriculture and Human Values.* Winter-Spring pp. 69-76.

Baker, D. and B. Spence 1988. "Afro-Caribbean Agriculture: A Jamaican Maroon Community in Transition." *The Geographical Journal* 154(2): 198-208.

Beers, J. 1991. "Implementing on-farm agroforestry research: lessons learned in Talamanca, Costa Rica." *Agroforestry Systems* 15: 229-243.

Biggs, S.D. 1989. *Resource-Poor Farmer Participation in Research: A Synthesis of Experiences from Nine National Agricultural Research Systems.* OFCOR Comparative Study Paper No. 3. The Hague: ISNAR.

Blustain, H.S. 1981. "Customary Land Tenure in Rural Jamaica: Implications for Development." In H.S. Blustain and E. LeFranc eds. *Strategies for Organization of Small-Farm Agriculture in Jamaica.* Mona, Jamaica: ICER, Univ. of West Indies.
Borel, R. and F. Romero 1991. "On-farm Research in a Silvopastoral Project: A Case Study". *Agroforestry Systems* 15: 245-257.

Buck, L. 1990. "Planning Agroforestry Extension Projects: The Care International Approach in Kenya." In W.W. Budd, I. Duchhart, L.H. Hardestry and F. Steiner (eds.) *Planning for Agroforestry: Developments in Landscape Management*. New York: Elsevier Science Publishing Co., Inc.

Butler, L.M. and R.O. Butler 1987. "Needs Assessment in International Development." In D.E. Johnson, et al., (eds.) *Needs Assessment: Theory and Practice*. Ames , Iowa: Iowa State University Press.

Byerlee, D. and R. Tripp 1988. "Strengthening Linkages in Agricultural Research Through a Farming Systems Perspective: The Role of the Social Scientist". *Experimental Agriculture* 24: 137-151.

Casley, D.J. and D.A. Lury 1987. *Data Collection in Developing Countries.* Oxford: Clarendon Press.

Casley, D.J. and K. Kumar 1988. *The Collection, Analysis, and Use of Monitoring and Evaluation Data.* Baltimore: The John Hopkins University Press.

Cernea, M.M., J.K. Coulter, F.A. Russell (eds.) 1985. *Research - Extension - Farmer: A Two-Way Continuum for Agricultural Development*. A World Bank and UNDP Symposium. Washington D.C.: The World Bank.

Chambers, R., R. Longhurst, D. Bradley and R. Feachem 1981. "Conclusions and Practical Implications." In R. Chambers, R. Longhurst, and A. Pacey (eds.) *Seasonal Dimensions to Rural Poverty*. London: Francis Pinter (Pub.) Ltd.

Collinson, M.P. 1987. "Farming Systems Research: Procedures for Technology Development." *Experimental Agriculture* 23: 365-386.

Cook, C.C. and M. Grut 1989. *Agroforestry in Sub-Saharan Africa: A Farmer's Perspective*. World Bank Technical Paper Number 112. Washington, D.C.: The World Bank.

Dasgupta, S. and R.N. Mallick 1992. "FSR and NGO: Partners for Sustainable Development of Resource-Poor Farmer." Paper presented at the International Farming Systems Research/Extension Symposium, Michigan State University, 14-18 September 1992.

Echeverría, R.G. (ed.) 1990. *Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research.* Volume II: Assessing the Impact of Agricultural Research. Proceedings of the ISNAR/Rutgers Agricultural Technology Management Workshop, 6-8 July 1988, Rutgers University, New Jersey, USA.

Etling, A.W. and R.B. Smith 1994. "Participatory Needs Assessment: A Key to FSRE." *Journal for Farming Systems Research-Extension* 4(2): 45-56.

Evans, P.T. 1988. "Designing Agroforestry Innovations to Increase Their Adoptability: a Case Study from Paraguay." *Journal of Rural Studies* 4(1): 45-55.

Ewell, P.T. 1989. *Linkages Between On-Farm Research and Extension in Nine Countries,* OFCOR Comparative Study No. 4. The Hague: International Service for National Agricultural Research (ISNAR).

Farrington, J. 1988a. "Farmer Participatory Research: Editorial Introduction." *Experimental Agriculture* 24:269-279.

Farrington, J. 1988b. "Private Voluntary Organizations as a Link Between Resource-Poor Farmers and Formal Agricultural Research and Extension Services - Unexploited Potential? A Proposal for Research." Workshop on "Operational approaches for participative technology development in sustainable agriculture", ILEIA, Leusden, 11-12 April, 1988.

Farrington, J. and A.J. Bebbington 1992. "From Research to Innovation: Getting the Most From Interaction With NGOs in FSR/E." Paper presented at the International Farming Systems Research/Extension Symposium, Michigan State University, 14-18 September 1992.

Flora, C.B. 1992. "Evaluation and Impact of the Global Synthesis and Networking." Paper presented at the 12th Annual Association of Farming Systems Research/Extension Symposium, Michigan State University, 13-18 September 1992, East Lansing.

Ford, R. 1989. An Introduction to Participatory Rural Appraisal for Rural Resource Management. Program for International Development, Clark University, Worcester, Massachusetts.

Fortmann, L. and N. Nabane 1992. "The Fruits of Their Labours: Gender, Property and Trees in Mhondoro District." Centre for Applied Social Sciences Occasional Paper Series - NRM ; 6/1992. University of Zimbabwe, Harare.

Francis, P.A., and A.N. Atta-Krah 1989. "Sociological and Ecological Factors in Technology Adoption: Fodder Trees in Southeast Nigeria." *Experimental Agriculture* 25: 1-10.

Gibbs, C.J.N. 1985. "Rapid Rural Appraisal: An Overview of Concepts and Applications." In Grandstaff, Grandstaff, and Lovelace, *Rapid Rural Appraisal: Proceedings of the 1985 RRA Conference.*

Gold, M.A. and L.W. Tombaugh 1987. "Understanding Interdisciplinary Research and its Application to Agroforestry Systems Research." In How Systems Work - Proceedings of Farming Systems Symposium 1987. University of Arkansas, Fayetteville, AR.

Hensleigh, T.E. and B.K. Holaway (eds.) 1988. *Agroforestry Species for the Philippines.* Washington, D.C.: United States Peace Corps.

Hildebrand, P.E. 1986. "The Sondeo: A Team Rapid Survey Approach." In P.E. Hildebrand (ed.) *Perspectives on Farming Systems Research and Extension.* Boulder: Lynne Rienner Publishers.

Hildebrand, P.E. 1981. "Combining disciplines in rapid appraisal: The Sondeo approach." *Agricultural Administration* 8: 423-432.

Holden, S.T. and O.J. Lawrence (1991). "Farmer Participatory Research and Agroforestry Development - A Case Study from Northern Zambia." *Agricultural Systems* 36: 173-189.

Horten, D. 1986. "Farming Systems Research: Twelve Lessons from the Mantaro Project." *Agricultural Administration* 23: 93-107.

Horton, D.E. 1990. "Assessing the Impact of International Research: Concepts and Challenges." In *Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research.* Volume II: Assessing the Impact of Agricultural Research. Proceedings of the ISNAR/Rutgers Agricultural Technology Management Workshop, 6-8 July 1988, Rutgers University, New Jersey, USA.

Hunter, G. (ed.) 1982. "Enlisting the Small Farmer: The Range of Requirements." Agricultural Administration Unit 5 Occasional Paper No. 4. London: Overseas Development Institute (ODI).

Horowitz, D. (ed.) 1990. *Making the Link: Agricultural Research and Technology Transfer in Developing Countries.* Boulder: Westview Press.

JLA. 1983. *Livestock Manual for the Tropics.* Kingston, Jamaica: The Jamaican Livestock Association.

Jones, R.J. 1979. "The Value of *Leucaena leucocephala* as a Feed for Ruminants in the Tropics". *World Animal Review* 31:13-23.

Kerkhof, P. 1990. *Agroforestry in Africa: A Survey of Project Experience*. London: Panos Publications, Ltd.

Kidd, C.V. and D. Pimentel. (eds.) 1992. *Integrated Resource Management: Agroforestry for Development*. Academic Press, Inc.

Koppel, B. 1990. "The Need to Know: Monitoring and Evaluating Agricultural Technology Management." In R.G. Echeverría (ed.) *Methods for Diagnosing Research System Constraints and Assessing the Impact of Agricultural Research.* Volume II: Assessing the Impact of Agricultural Research. Proceedings of the ISNAR/Rutgers Agricultural Technology Management Workshop, 6-8 July 1988, Rutgers University, New Jersey, USA.

Krecik, Steve 1993a. *Fodder Tree Establishment and Production in Seasonally Dry Areas of Jamaica.* M.S. Thesis, Michigan State University, East Lansing, MI.

Krecik, S., D.O. Lantagne, M.A. Gold, and J.M. Roshetko 1994. "Cutting Management of *Leucaena leucocephala*, *Calliandra calothyrsus*, and *Gliricidia sepium* for Fodder Production." Nitrogen Fixing Tree Research Report Vol. 11.

Le Houérou , N.H. (ed.) 1980. *Browse in Africa: The Current State of Knowledge*. Addis Ababa: ILCA. 491 p.

Lightfoot, C., O. De Guia Jr., and F. Ocado 1988. "A Participatory Method for Systems-Problem Research: Rehabilitating Marginal Uplands in the Philippines." *Experimental Agriculture* 24: 301-309.

Little, P.D. 1985. "Adding a Regional Perspective to Farming Systems Analysis: Concepts and Analysis." *Human Organization* 44(4) Winter: 331-338.

MacDicken, K.G., G.V. Wolf, and C.B. Briscoe (eds.) 1991. *Standard Research Methods for Multipurpose Trees and Shrubs*. Winrock International Institute for Agricultural Development.

Malla, Y.B. 1988. "The Case for Placing More Emphasis on Private Tree Planting Programmes." Forestry Research Paper Series No. 13. HMG-USAID-GTZ-FORD-WINROCK Project. Kathmandu, Nepal.

Maurya, D.A., A. Bottrall, and J. Farrington 1988. "Improved Livelihoods, Genetic Diversity and Farmer Participation: A Strategy for Rice Breeding in Rainfed Areas of India." *Experimental Agriculture* 24: 311-320.

Merrill-Sands, D. and J. McAllister 1988. *Strengthening the Integration of On-Farm Client-Oriented Research and Experiment Station Research in National Agricultural Research Systems (NARS): Management Lessons from Nine Country Case Studies.*

OFCOR Comparative Study Paper No. 1. The Hague: International Service for National Agricultural Research (ISNAR).

Morikawa, R 1993. "Fodder Tree Establishment and Utilization in a Seasonally Dry Area of Jamaica." Paper presented at the Fifth Annual Jamaican Agricultural Seminar of the Jamaican Agricultural Research Program (JARP), July 1993, Kingston Jamaica.

Morrison, B.J. 1991. *Indigenous Knowledge Relating to Fodder Trees and Silvo-pastoral Management Systems of Small-Scale Farmers in Jamaica.* M.S. Thesis, Michigan State University, East Lansing, MI.

Nair, P.K.R. 1993. *An Introduction to Agroforestry.* The Netherlands: Kluwer Academic Publishers.

Nair, P.K.R. 1992. "Agroforestry Systems: An Ecosystem Approach." In N.P. Sharma (ed.) *Managing the World's Forests.* Iowa: Kendall/Hall Publishing Co.

Ndufa, J.K., E. Ohlsson, and K.D. Shepherd 1992. "Participatory Research Methods for Agroforestry Technology Development in Western Kenya." Paper presented at the 12th Annual Association for Farming Systems Research Symposium, 13-18 September 1992, Michigan State University, East Lansing.

Noronha, R. and J.S. Spears 1985. "Sociological Variables in Forestry Project Design." In M.M. Cernea *Putting People First. Sociological Variables in Rural Development.* World Bank.

Pandy, K. 1982. Fodder Trees and Tree Fodder in Nepal. Swiss Development Cooperation. Berne, Switzerland.

Pinners, E. and V. Balasubramanian 1991. "Use of the Iterative Diagnosis and Design Approach in the Development of Suitable Agroforestry Systems for a Target Area." *Agroforestry Systems* 15: 183-201.

Pinney, A. 1991. "Farmer Augmented Designs for Participatory Agroforestry Research." *Agroforestry Systems* 15: 259-274.

Raintree, J.B. 1983. "Strategies for Enhancing the Adoptability of Agroforestry Innovations." *Agroforestry Systems* 1:173-187.

Raintree, J.B. 1987. *D&D User's Manual: An Introduction to Agroforestry Diagnosis and Design.* Nairobi, Kenya: International Council for Research in Agroforestry.

Raintree, J.B. 1990. "Agroforestry Diagnosis and Design: Overview and Update." In W.W. Budd, I. Duchhart, L.H. Hardestry, and F. Steiner (eds.) *Planning for*

Agroforestry: Developments in Landscape Management. New York: Elsevier Sciences Publishing Co., Inc..

Raintree, J.B. and F. Torres 1986. Agroforestry Research in Farming Systems Perspective: The ICRAF Approach. ICRAF Working Paper No. 39. ICRAF, Nairobi, Kenya.

Rajasekaran, B. 1992. "Farmer Participatory Approaches to Integrate Indigenous Knowledge Systems and Research Station Technologies Toward Sustained Food Production and Resource Conservation in India." Paper presented at the 12th Annual Association for Farming Systems Research/Extension, 13-18 September 1992, Michigan State University, East Lansing.

Reynolds, L., C. di Domenico, A.N. Atta-Krah, and J. Cobbina 1991. "Alley Farming in South-Western Nigeria: The Role of Farming Systems Research in Technology Development." In R. Tripp (ed.) *Planned Change in Farming Systems*. New York: John Wiley & Sons

Rhodes, R., R. Booth, E. Schmidt, and O. Cuyubamba 1991. "Post-Harvest Technology Development with Farmers: The Diffused Light Storage Case." In R. Tripp (ed.) *Planned Change in Farming Systems*. New York: John Wiley & Sons.

Rocheleau, D.E. 1991. "Participatory Research in Agroforestry: Learning From Experience and Expanding Our Repertoire." *Agroforestry Systems* 15: 111-137.

Rocheleau, D.E. 1985. "Criteria for Re-appraisal and Re-design: Intra-household and Between-household Aspects of FSRE in Three Kenyan Agroforestry Projects." Paper presented at the Annual Farming Systems Research and Extension Symposium, Kansas State University, Manhattan Kansas, 7-10 October 1984. ICRAF Working Paper No. 37.

Rocheleau, D.E. 1984. "Land Use Planning With Rural Farm Households and Communities: Participatory Agroforestry Research." Paper presented to the Networkshop on the Role of the Sociologists and Anthropologists in Farming Systems Research. Sponsored by ARPT Zambia and CIMMYT East Africa, 27-29 November 1984, Lusaka Zambia.

Rocheleau, D.E., F. Weber, and A. Field-Juma 1988. *Agroforestry in Dryland Africa.* Nairobi: ICRAF.

Roshetko, J.M. 1991. *Establishment and Nutritive Value of Native and Exotic Fodder Tree Species in Jamaican Pasture Systems.* M.S. Thesis, Michigan State University, East Lansing, MI.

Rusten, E.R. 1989. *An Investigation of an Indigenous Knowledge System and Management Practices of Tree Fodder Resources in the Middle Hills of Central Nepal.* Ph.D. Dissertation, Michigan State University, East Lansing, MI.

Sagar, D. and J. Farrington 1988. "Participatory Approaches to Technology Generation: From the Development of Methodology to Wider-Scale Implementation." Agricultural Administration Network Paper No.2 Agricultural Administration Network. London: Overseas Development Institute.

Scherr, S.J. 1991. "On-Farm Research: The Challenges of Agroforestry." *Agroforestry Systems* 15: 95-110.

Shaner, W.W., P.F. Philipp, W.R. Schmehl 1982. *Farming Systems Research and Development*. Boulder: Westview Press.

Sharma, N.P, R, Rowe, M. Grut, R. Kramer and H. Gregersen (1992). "Conditions for Sustainable Development." In N.P. Sharma (ed.) *Managing the World's Forests*. Iowa: Kendall/Hall Publishing Co.

SIOJ 1991. *Statistical Yearbook of Jamaica - 1991*. Kingston: The Statistical Institute of Jamaica.

Sumberg, J. and C. Okali 1988. "Farmers, On-Farm Research and the Development of New Technology." *Experimental Agriculture* 24: 333-342.

Torres, F. 1983. "Role of Woody Perennials in Animal Agroforestry." *Agroforestry Systems* 1:131-163.

Tripp, R. 1991a. "An Overview of the Cases of On-Farm Research." In R. Tripp (ed.) *Planned Change in Farming Systems*. New York: John Wiley and Sons

Tripp, R. 1991b. "The Limitations of On-Farm Research." In R. Tripp (ed.) *Planned Change in Farming Systems*. New York: John Wiley and Sons

Tripp, R. and J. Woolley 1989. *The Planning Stage of On-Farm Research: Identifying Factors for Experimentation.* Colombia: CIMMYT and CIAT.