CIMMYT

INTERNATIONAL MAIZE AND WHEAT
IMPROVEMENT CENTER

Understanding the Farmer's Agricultural Environment in Malawi

Bernard C.G. Kamanga
CIMMYT-Malawi, Bunda College of Agriculture, Lilongwe, Malawi

NRG

Natural Resources Group

Risk Management Projects Working Paper
Series 02-01

CIMMYT® (www.cimmyt.org) is an internationally funded, nonprofit, scientific research and training organization. Headquartered in Mexico, CIMMYT works with agricultural research institutions worldwide to improve the productivity, profitability, and sustainability of maize and wheat systems for poor farmers in developing countries. It is one of 16 food and environmental organizations known as the Future Harvest Centers. Located around the world, the Future Harvest Centers conduct research in partnership with farmers, scientists, and policymakers to help alleviate poverty and increase food security while protecting natural resources. The centers are supported by the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org), whose members include nearly 60 countries, private foundations, and regional and international organizations. Financial support for CIMMYT's research agenda also comes from many other sources, including foundations, development banks, and public and private agencies.

FUTURE HARVEST

Future Harvest® builds awareness and support for food and environmental research for a world with less poverty, a healthier human family, well-nourished children, and a better environment. It supports research, promotes partnerships, and sponsors projects that bring the results of research to rural communities, farmers, and families in Africa, Asia, and Latin America (www.futureharvest.org).

© International Maize and Wheat Improvement Center (CIMMYT) 2002. All rights reserved. The opinions expressed in this publication are the sole responsibility of the authors. The designations employed in the presentation of materials in this publication do not imply the expression of any opinion whatsoever on the part of CIMMYT or its contributory organizations concerning the legal status of any country, territory, city, or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. CIMMYT encourages fair use of this material. Proper citation is requested.

Correct citation: Kamanga, B.C.G. 2002. *Understanding the Farmer's Agricultural Environment in Malawi.* Risk Management Project Working Paper 02-01.

Abstract: The AusAID/ACIAR/CIMMYT Risk Management Project develops resource-conserving farming methods in collaboration with smallholder farmers, combining use of crop simulation modeling and farmer participatory research (FPR). In 1999 research was undertaken in Chisepo and Songani, Malawi, to describe and understand the farmer's environments through farmer stratification, soil classification, and diagnosis of cropping systems. Results revealed that institutional linkages play vital roles in farmers' daily lives. Four classes of farmers (the richest, rich, poor, and the very poor) were identified based on wealth. Wealth was defined as having enough land, good housing, oxcarts, and some livestock. The most common soils in Chisepo are sandy soils, while sandy loam soils are most common in Songani. Agricultural crops grown on these soils in Songani include maize (the staple food), groundnuts, pigeon peas, cassava, sorghum, beans, and pumpkins, while tobacco and sweet potatoes are additional crops in Chisepo.

ISSN: 1665-045X
AGROVOC descriptors: Farming systems; Cropping systems; Agricultural policies; Resource conservation; Resource management; Simulation models; Small farms; Maize; Groundnuts; Pigeon peas; Cassava; Sorghum; Pumpkins; Malawi
AGRIS category codes: F08 Cropping Patterns and Systems
P01 Nature Conservation and Land Resources
Dewey decimal classification: 630.6897

Printed in Mexico.

Contents

Tables

Figures

Abbreviations and Acronyms

ACIAR	Australian Centre for International Agricultural Research
ADMARC	Agricultural Development and Marketing Corporation
AusAID	Australian Aid for International Development
CIMMYT	International Maize and Wheat Improvement Center
DANIDA	Danish International Development Assistance
EU	European Union
GTZ	Gesellschaft fur Technische Zusammenarbeit
ICLARM	International Center for Living Aquatic Resources Management
ICRAF	International Centre for Research in Agroforestry
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
RDP	Rural Development Program
SACCO	Savings and Credit Cooperatives
SEDOM	Small Enterprises Development Organization on Malawi

Understanding the Farmer’s Agricultural Environment in Malawi

Summary

The goal of the AusAID/ACIAR/CIMMYT Risk Management Project is to develop sustainable and resource-conserving farming methods in collaboration with smallholder farmers. It uses a twin approach, combining crop simulation modeling and farmer participatory research (FPR). Modeling assesses crop biophysical response to climate, soil type, and management. The outcomes are used to develop alternative practices for sustaining yields under given risks. Farmer participatory research provides reality checks to the model from the farmers’ viewpoints. In 1999 research was undertaken in Chisepo and Songani, Malawi, to describe and understand the farmer’s environments through farmer stratification, soil classification, and diagnosis of cropping systems. Group discussions and surveys were used to collect information from farmers. Institutional analysis, wealth ranking, and cropping systems diagnosis were performed. Results revealed that institutional linkages to farmers play vital roles in day-to-day life. The most important institutions are ADMARC, where people buy food, schools, hospitals, markets, churches, and the police. Four classes of farmers (the richest, rich, poor, and the very poor) were identified based on wealth. Wealth was defined as having enough land, good housing, oxcarts, and some livestock. The most common soils in Chisepo are sandy soils, while sandy loam soils are most common in Songani. Agricultural crops grown on these soils in Songani include maize (the staple food), groundnuts, pigeon peas, cassava, sorghum, beans, and pumpkins, while tobacco and sweet potatoes are additional crops in Chisepo.

Introduction

Domestic food production has consistently been too low to sustain Malawi’s increasing population. Among the factors affecting food production, low soil fertility is one of the most important. Farmers’ efforts over the decades to increase production have had minimal results. Crop yields continue to decline (Government of Malawi 1996), making many households food insecure. Consequently these households are forced to engage in off-farm activities or sell their labor to survive, though returns from the sale of labor are rarely sufficient. Child malnutrition becomes a common problem, which further reduces the labor potential of households (Ng’ong’ola and Mangisoni 1994). If this cycle is not broken, most smallholder farmers will remain poor.

To help break the cycle of poverty, work is underway on the development and extension of technologies to restore soil fertility. It is important that these technologies complement and improve farmers’ current practices and not just introduce new ideas (Kanyama-Phiri et al*.* 1998)*.* In the past, many of the technologies developed by researchers have not been adopted (Snapp 1995; Benson 1997). One reason for this is that sometimes the actual returns of the technology are much lower than those promised, making them too risky for farmers to adopt.

Technologies developed without farmer input are less likely to be adopted (Brummett and Chikafumbwa 1999). Understanding the farmer’s environment is crucial because it helps to identify the nature of the work required to modify existing farming practices. Analysis of human behavior, particularly with respect to farming practices, is a key issue in the adoption of new technologies (Thrupp 1989).

This paper describes farmers' environments in two research areas in Malawi. Part I gives an overview of the project and its objectives. It also describes the sites, as well as the institutes linked to the farmers and the influence they have on agriculture. Part II outlines the classifications of farmers, soils, and seasons developed by the farmers themselves. It also describes the criteria associated with the classifications and gives an overview of how they influence farming practices in the project areas. Part III details the cropping systems that farmers have developed and modified over time.

Part I: Project Background and Institutional Analysis

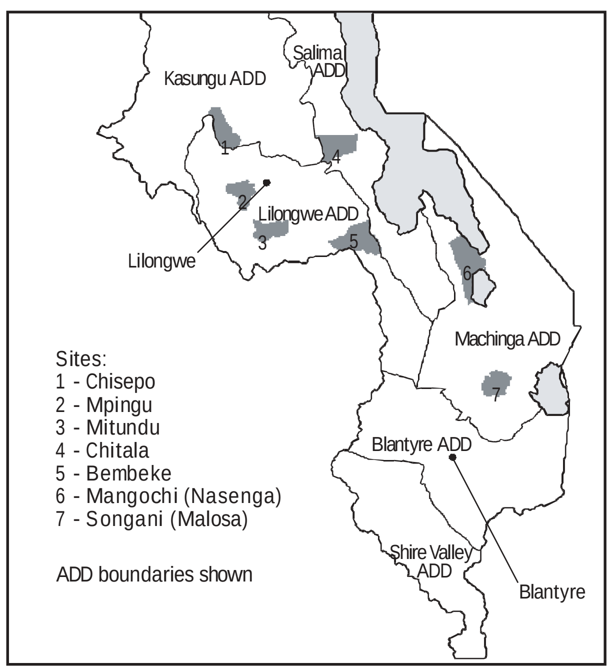
The Risk Management Project

The Risk Management Project (RMP) is funded by AusAID and ACIAR through the CIMMYT Natural Resources Group. The goal of the RMP is to develop sustainable and resource-conserving farming methods in collaboration with smallholder farmers, working from a systems perspective and using simulation models and farmer participatory research. The Project ultimately aims to expand farmers' soil fertility and resource management options, with special attention to those that can help maintain production under even the harshest conditions.

The project operates in Malawi (Figure 1) and Zimbabwe where climatic risk due to rainfall is a major production constraint. Other production constraints include famine, disease, pests, a lack of farming knowledge, soil infertility, and poverty. Poverty, for example, affects resource acquisition and allocation by farmers. Those with more resources are able to take risks in different seasons, while the poor have to critically weigh each option to best accommodate their scarce resources. Risk influences the modification of agronomic practices, choice of crop varieties grown, level of inputs used, and the adoption of new technologies.

Farmers use various strategies to cope with these crisis situations. During hunger periods, for example, some households adjust their consumption pattern by either reducing the number of meals to one per day or by reducing the amount of food eaten each mealtime. In serious cases, households just eat pumpkin leaves or maize bran, when they can find it. Some households sell labor to wealthier farmers and use the cash to buy food (Leach 1995). Some join farmers' clubs to gain access to inputs (fertilizer and seed) so that they can increase

Figure 1. Farmer-participatory legume research sites in Malawi.



production. Other farmers grow additional, earlier maturing, food crops with their maize, such as pigeon peas, pumpkins, sweet potatoes, and cucumbers (Peter and Herera 1989; Leach 1995), so that they have food to eat before the maize matures and produce to sell at the market for cash (Bjornson and Innes 1992).

The productivity of farming systems can be increased through the development and adoption of production-enhancing and resource-conserving practices (Becker 1990). In southern Africa, over 80% of maize produced is rainfed but much of the region has erratic rainfall, posing big climatic risks to agricultural production. In addition, most soils have lost their inherent fertility and do not produce good crop yields (Hardy 1998; Snapp 1998). Farmers, however, develop and modify their practices to suit the prevailing conditions. In so doing, they have acquired vast experience and knowledge that can be combined with researchers' knowledge to develop and improve smallholder practices.

Project Activities. The Risk Management Project combines farmer participatory research (FPR) with modeling. The aim of FPR is to provide an understanding of farming families in an area. It focuses on obtaining farmers' knowledge of their farming systems and understanding the complexity of farming systems from the farmer's viewpoint. This information is used to develop scenarios for better managing crops and resources under different conditions. These scenarios are then subjected to modeling simulations using the APSIM model, which assesses biophysical crop responses under various crop and soil management strategies.

All of this information is combined to provide an understanding of the factors influencing farming environments to improve the adoption of technologies and, hence, improve agricultural production. The process is iterative, in that research questions for the modeling stage are developed from farmers' practices and farmers evaluate the results produced by the crop simulation model. This process will help farmers suggest modifications to production practices to improve the adoption of new technologies.

Research Sites

The research is conducted at two sites: Chisepo in Chisepo Extension Planning Area (EPA) and Kasungu Agricultural Development Division (ADD), central Malawi; and Songani in Malosa EPA, Zomba Rural Development Program (RDP), Machinga ADD, southern Malawi. Figure 1 shows seven legume research sites in Malawi, including Chisepo (1) and Songani (7), managed by CIMMYT; Bunda College, Chitedze; and ICRISAT. Sites 1, 4, and 7 also include on-station modeling trials conducted by the Maize Commodity Team at Chitedze Research Station.

Chisepo, Kasungu. Chisepo is located within the Kasungu mid-altitude plain at 13^o 32' S and 33^o 31' E and an elevation of 1240 meters above sea level (masl). The climate is semi-arid to sub-humid and is characterized by unimodal rainfall from November to April. The annual rainfall is 845 mm and mean temperature is 25^{o}C. Soils are predominantly alfisols of low to moderate fertility and sandy loams to loamy sand underlain by laterites, which impede drainage (Wendt 1993).

Current land use in Chisepo is intensive. Tobacco estates are widespread throughout the area. Average smallholding size is around 1.7 ha per household (Snapp et al. 1999). Maize is the most important food crop grown by smallholders in Chisepo—Chisepo is one of the major maize producing area in the central plains of Malawi. Farmers also grow groundnuts and tobacco as their main crops. Most maize is monocropped, though a few farmers intercrop it with pumpkins, sorghum, and cowpeas at low plant populations. Farmers mostly keep poultry, goats, and sheep, and a few cattle. The area is accessible throughout the season.

The people in the area are of the Chewa ethnic group, which practices a matrilineal system (where women are custodians of the land) (Werner 1987). This system affects decisions on how best to use and invest in the land (Ng'ong'ola 1986). Thirty-two farmers are involved in the research and are interested in the participatory development of technologies. Over the past two years the research has concentrated on integrating legumes into the farming systems to enhance farm productivity.

Songani, Zomba. The Songani catchment area is located in Zomba RDP at 15° 18.5' S and 35° 23.5' E and an elevation of 785-1200 masl. Soils in the area are alfisols and ultisols of moderate fertility, with clay loam occurring in the lower slopes and sandy loam in the upper slopes. Most of the fields in the upper slopes are characterized by rocky outcrops. Annual rainfall ranges from 800 to 1,200 mm and the mean annual temperature is 22.5°C. The rainfall season normally begins in October and finishes in April, followed by the *Chiperoni* rains from May to July. The *Chiperoni* rains are of great importance at this time of the year because they facilitate the decomposition of incorporated crop residues. While maize-based intercropping systems dominate the area, other important crops are cassava, pigeon peas, groundnuts, beans, and pumpkins (Peter and Herera 1997; Shaxson and Tauer 1992). The average landholding size in the area is 0.56 ha. (Kamangira 1997; Kanyama-Phiri et al. 1998). The people in this area also have a matrilineal system.

Maize is the most important crop in the study areas and is grown by all farmers, primarily for food. The study area lies within a catchment that drains into the inland lake, Lake Chilwa. It is also close to the municipality of Zomba where most farm produce is sold in markets. Selected socioeconomic variables of farmers in the areas are summarized in Table 1.

Analysis of Institutions and their Roles

The analysis of institutions linked to farmers was achieved through focus group discussions involving all farmers in the two areas. Farmers were asked to name all of the institutions in their area and then to describe the role of each institution or how they contribute to day-to-day life. They then ranked the institutions according their perceived importance, based on whether the institution was reliable and indeed serving the people.

For the purpose of this study, the term institution refers to formal and informal organizations. It also encompasses their associated norms, rules, and values which define the roles of the members of the institutions and their responsibilities and relationships within the community. The importance of an institution is defined by its relationship with members of the community. Farmers in Chisepo and Songani identified 49 institutions, grouped into 6 categories, including social service institutions, nongovernmental organizations (NGOs), agricultural institutions, financial institutions, and marketing and central administration institutions (Table 2).

Table 1. Socioeconomic characteristics of farmers in the study area.

Variable	Chisepo	Songani
Household size	4.70	5.80
Consumer:worker ratio	1.30	1.50
Farm size (ha)	1.70	0.56
Average maize yield (t/ha)		
Local varieties	0.87	0.74
Hybrids	1.42	1.32
Maize provision ability[1] (months)	7.30	6.90
Fertilizer use on maize (kg/ha N)	19.00	17.00
Manure use on maize (% of farmers)	18.00	29.00
Primary education of household heads (years)	4.10	3.80

[1] Number of months between the time of maize harvest and when household maize stocks run out.
Source: Kamanga (1999); Snapp et al. (1999).

Institutional ranking by farmers

The institutions were ranked using criteria defined by farmers in Chisepo, based on whether the institution was helpful, trustworthy, impartial, understanding, kind, or conciliatory. Helpful institutions were defined as those that provide help when needed and are essential to the community. Trustworthy institutions are reliable, exemplary in providing good advice to farmers, and effective. Impartial institutions are those that help anyone, regardless of ethnic background, and practice fairness in all situations. Understanding institutions are those that respond to farmers' problems in time and with concern. These encourage farmers to get involved in the process of helping themselves.

Table 2. Institutions identified by farmers in Chisepo and Songani, Malawi.

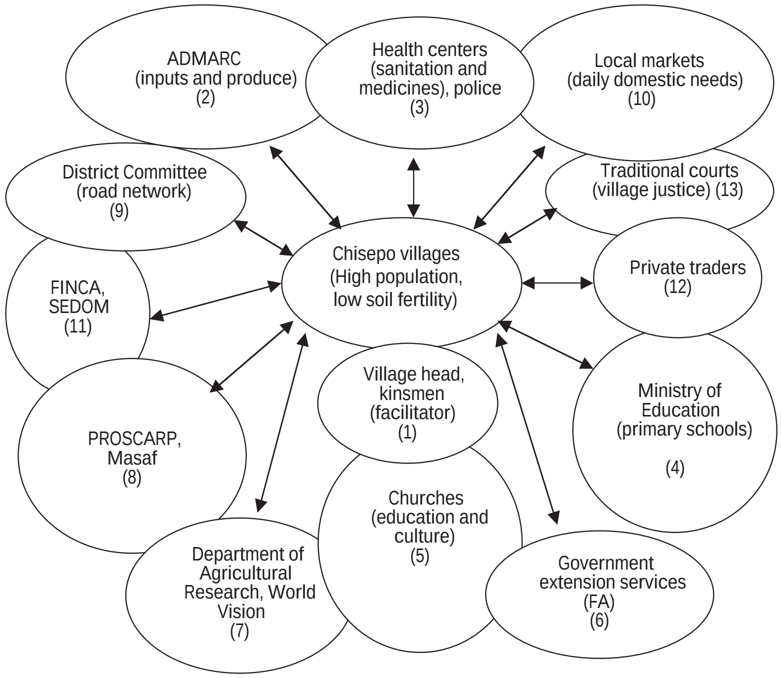
Institutions	Chisepo	Songani
Traditional	Village chief, village headman, kinsmen, marriage counselors, traditional birth attendants, herbalists, grave diggers, traditional courts, *nyau*[1] dancers, hospitals, schools, churches, maize mills.	Traditional courts, village chief, village headman, kinsmen, marriage counselors, traditional birth attendants, herbalists, traditional courts, elders.
Non-governmental	CIMMYT, World Vision, Danida, Proscarp, ICRISAT, Masaf.	CIMMYT, GTZ, ICRAF, ICLARM, World Vision, EU.
Agricultural	ADMARC, farmers' clubs (Burley Tobacco), Tobacco Association of Malawi, Farmers World, field assistant.	ADMARC, Farmers World,farmers' clubs, Department of Research, Bunda College, field assistant.
Financial	SEDOM, banks, FINCA.	FINCA, SACCO, bank, private moneylenders.
Marketing	Hawkers, grocers and shops, markets, ADMARC, private traders.	Grocers and shops, Municipality of Zomba, market, ADMARC, Rab Processors Ltd.
Government	Police, agriculture (ADD, RDP, EPA, field assistant), member of parliament, government, teachers, party leaders.	President, member of parliament, police, party leaders, mayor, agricultural development officers. schools, hospitals, courts, churches, District Commissioner.

[1] Traditional spiritual dance.

Farmers discussed each institution based on the above criteria and gave them a score out of 100. An overall ranking was produced, as well as a ranking within each category (refer to Table 2). The top 12 institutions in Chisepo and Songani are shown in Figures 2a and 2b, respectively.

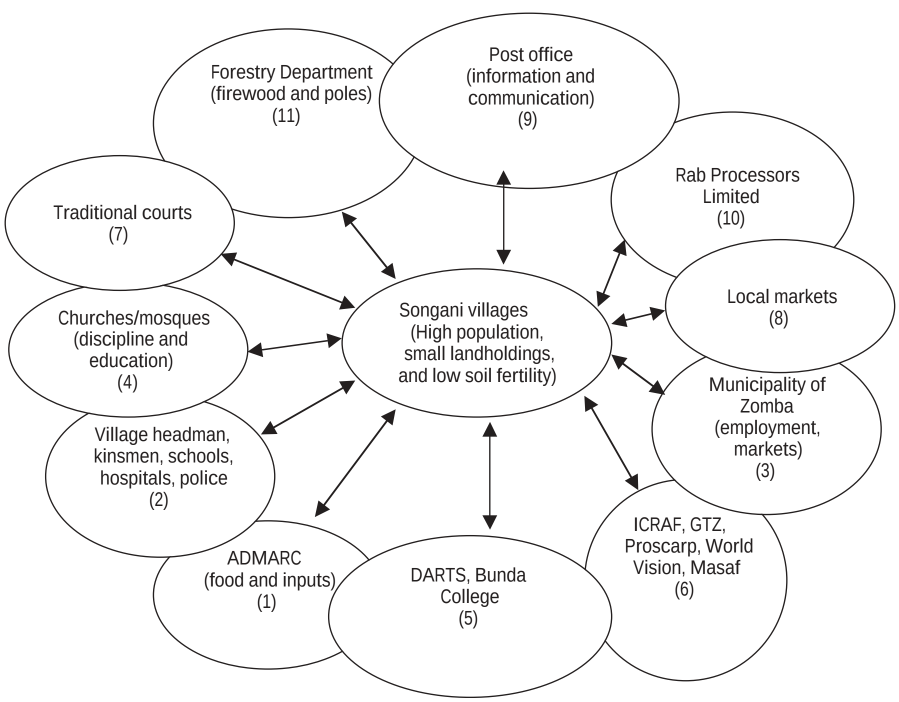
In the social service group, kinsmen and marriage counselors were deemed most important in Chisepo and second most important in Songani. Their direct influence on the day-to-day life of individuals was identified in both sites. Kinsmen groups allow individuals to participate in decision making and implementation. In crisis situations such as famine, illness, or death, they help each other with food, farm inputs, care, and comfort. These groups are helpful, understanding, and dependable. In Chisepo hospitals, schools, and churches were ranked third, fourth, and fifth, respectively, while in Songani the hospital and school were both ranked second and the church was ranked fourth. Hospitals provide medical care and family planning, which improve people's health and reduce mortality rates. Healthy people contribute greatly to agricultural production through physical labor. The mission hospital in Songani has implemented a small ruminant project to improve the availability of animal proteins to families. It also provides free food to clinics for children under five years old to reduce food insecurity. Schools and churches help to maintain the cultural integrity of communities through the provision of education and good advice to children. Education is very important in decision making. Churches in both areas help with the administration of schools and also in the provision of water boreholes, which provide clean water to farmers and help to reduce disease. Schools and churches are examples of helpful institutions.

Figure 2a.



The numbers in parenthesis indicate the ranking of institutions by their importance to farmers. Those institutions that were ranked at the same position are put in the same circle. The figures show only the first twelve institutions in each site. Both sites used the same criteria developed by the farmers at Chisepo and accepted in Songani.

Figure 2b.



Within the agricultural institution category, ADMARC was ranked second in Chisepo and first in Songani. ADMARC is the biggest supplier and buyer of inputs and outputs in Malawi. It was considered most important because it acts as the grain reserve for farmers and rescues them during food crises. It offers a constant and dependable source of food, hence it is considered a trustworthy institution. Rich farmers use some ADMARC maize for in-kind payments to poorer households that sell labor. Its outlets are accessible and it stocks every food crop that farmers need. It also sells improved inputs such as fertilizers, chemicals, and seeds of various crops. These inputs, in turn, increase crop production and reduce the risk of food insecurity. Another agricultural institution, the field assistant (FA), was ranked sixth in both Chisepo and Songani. The FA instructs farmers on how to obtain high yields in day-to-day agricultural life by providing information on new varieties and chemicals. As a community member, the FA is at the farmer’s disposal when, for example, recommendations and techniques are required for maximizing yields and reducing risks during drought or heavy rains. Research institutions (ranked seventh in Chisepo and fifth in Songani) were also deemed very important in the study area. In Chisepo, the most important research institution was the Department of Agricultural Research (DAR), whose services are provided through the Maize Commodity Team. DAR provides technical advice to extension workers and farmers on fertilizer use, varieties, planting dates and methods, and weeding. DAR also conducts research at the two sites through which farmers acquire inputs such as seed, fertilizer, and information on crop improvement.

Among nongovernmental organizations (NGOs), World Vision was ranked seventh in Chisepo, followed by PROSCARP and Masaf. World Vision works with farmers to improve food security through the provision of small irrigation facilities for the production of dimba (wetland)-based crops such as maize, beans, vegetables, and potatoes. The produce is consumed or sold to satisfy immediate cash requirements. PROSCARP is important in the implementation of soil-conserving measures such as contour bund planting of vetiver grass in farmers’ fields, which reduces the loss of topsoil. In Songani, ICRAF GTZ, World Vision, and Masaf were ranked sixth. ICRAF is currently implementing legume-based research with farmers in the area to promote food production. Farmers have registered increased maize yields under the legume-based technologies (Kanyama-Phiri et al. 1998).

Most farmers in the study area have not benefited from financial institutions. Only three farmers reported access to loans: two from FINCA in Songani and one from SEDOM in Chisepo. Nevertheless, farmers pointed out that these institutions were very important and that if they modified their lending policies, farmers would benefit greatly. Most farmers said they were willing to take out loans to improve their agricultural practices.

The police were considered very important in both sites. They were ranked third in Chisepo and second in Songani. The communities in both areas benefit from security provided by the police.

Songani, due to its proximity to Zomba, produces and supplies the town market with commodities including green pigeon pea grain, cassava, mucuna, and marketable fruits. It also offers temporary and permanent employment. Not surprisingly, the Municipality of Zomba was ranked third among marketing institutions by farmers in Songani. For other institutions, rankings did not differ from those in Chisepo, illustrating that food production and availability are the main human welfare issues facing farmers in the area.

The RMP enjoys partnerships with several institutions that share similar objectives focused on the common man (Table 3). Institutions with a direct link to the RMP through collaborative work or other means were identified as partners of the project. The exercise was carried out at the beginning of the project and identified the following stakeholders: World Vision Malawi, University of Malawi, NARS, ICRISAT, Government Extension Service, and the farmer.

An issue that arose during the analysis was the control that farmers had over the institutions. It was made clear that the farming communities have control over some institutions such as the kinsmen, nyau, graveyard diggers, and schools, to a lesser extent. Institutions over which farmers have no influence, such as the hospital, police, and ADMARC, are mostly very important. Institutions that conduct research in conjunction with farmers should identify farmers' needs. It is very important that farmers have input into making decisions about the options that help to address their needs. It is also important to know the different classes of farmer in an area, the type of production decisions each makes, and how such decisions influence production. This information helps to target new technologies more accurately within the farming community.

Table 3. Institutes in partnership with the Risk Management Project (RMP), Malawi.

Partners	Interests defined by institution (ongoing)	Objectives defined for output	Involvement in RMP
Department of Agricultural Research and Technical Services (Maize Commodity Team)	Agricultural research on technology development on green manure, N management, and weed management in maize-based systems throughout the country.	Improvement of food security- in large and small scale agriculture.	Technology development, improvement, and testing. Input supply.
Farmer (primary stakeholder)	Improving food production.	Improvement of food and cash crop production.	Primary stakeholders in the success of RMP (indigenous knowledge and experience).
Government Extension Services (field assistants)	Technology information transfer (change agent).	mprovement of production methods.	Field activities such as farmer group discussions (resource persons).
ICRISAT	Research on semiarid crops for soil fertility improvement. Research on green manure (in central Malawi).	Food security. Seed multiplication.	Technology development. Input supply.
Soil Fertility Network	Research on soil fertility (green manure, rotations, and N management) in southern and central Malawi.	Food security. Dissemination of information through country tours.	On-farm research trials. Support for research methodology development. Regional leadership.
University of Malawi, Bunda College of Agriculture	Agricultural research on green manure, pigeon peas, mucuna, tephrosia, soybeans, and crotalaria in southern Malawi.	Food security. Academic research.	Technology development. Extension through on-farm research. Secondary data. CIMMYT-RMP link. Student studies.
World Vision International (Malawi)	Ongoing research on food security.	Food security. Infrastructure development.	Resource persons exchange. Technology development through resource allocation maps.

Summary

Part 1 illustrates the importance of the network of institutions that supports farmers in day-to-day life. Most agricultural decisions made by farmers are influenced by one or more of these institutions. It is important, therefore, that these links are well understood before any development work is undertaken. This also helps to ensure and maintain the flow of information within the development cycles. However, more information is required to thoroughly understand the farming environment: the farmer has to be known, soils have to be classified, and the influence that this information has on agricultural production needs to be identified. Part 2 describes the classifications of farmers and soils made by farmers in the study area.

Part II: Farmer, Soil, and Climate Classification

Identifying and categorizing farmers, soils, and cropping seasons are important for understanding farming households and their behavior in agricultural production (Bellon et al. 1999). This knowledge helps to target agricultural technologies where they will be of most benefit. This section describes how farmers in Chisepo and Songani classify themselves, their soils, and their cropping seasons.

In any farmer-related activity, defining the types of farmers involved is critical (Wellard 1996). Farmers belong to different societies with different characteristics, preferences, and resource endowments. This means that farmers are heterogeneous in their behavior and in the way they perform their agricultural activities (Malawi Government 1980). These differences are very influential in decision-making processes on the farm.

Soils vary in physical and biological properties from one location to another (Wendt 1993; Wendt et al. 1994). The management and crops suitable for each soil type depend on the soil properties (Wendt et al. 1994). To understand the farming environment, soils have to be defined and classified based on prevailing characteristics including most suitable crop types and management practices, climatic conditions, and location within the landscape catena. These characteristics influence the farmer's decisions on the type of crop to grow, fertilizer to use, and how and when to manage the soil in a particular environment.

Climate is one of the most important factors affecting agricultural performance. In Malawi there are two seasons (wet and dry), which are heavily influenced by prevailing climatic conditions such as temperature, rainfall, wind, and humidity. Knowledge of these conditions helps to modify agricultural management strategies.

The aim of the project component is to use the knowledge of smallholder farmers in Chisepo and Songani to improve their productivity. Information on farmers' management practices, soils, and climates is needed so that homogeneous categories can be developed (Bellon 1999). Scenarios representing different farmer situations can then be identified for each category and evaluated using simulation modeling, resulting in predictions of system productivity for each. The aim is to understand how different classes of farmers manage different soils across seasons.

This information is important for the development and adoption of technologies and the allocation of resources. These have often been offered to farmers on a broad scale without the benefit of such information, which has resulted in low adoption rates. The issue here is that farmers attach different values to the technologies, depending on their class. It is important, therefore, to work with farmers within their classes (Biggs 1989). Accordingly the RMP aims to identify farmers' strategies for coping with risk across the range of farmer categories within an area.

Participatory approaches such as wealth ranking, group discussions, and individual interviews were used to stratify farmers and classify soils and crop seasons. Farmers were grouped into female, male, and mixed groups to achieve full participation by gender groups and the extraction of independent group information. Group members developed the criteria used in the stratification processes, as described in the following sections.

Stratification of Farmers according to Wealth

Wealth ranking is used to classify farmers based on the ownership of resources that they perceive to be important. Wealth is subjectively defined—one farmer will explain it differently from another. Wealth influences opportunities for adoption of agricultural technologies (Gilbert et al. 1993).

As the first step in the exercise, farmers were asked to list any household assets. From this list, they developed a number of criteria for defining and describing the classes of farmers in the two study areas. The criteria included the level of resources owned by a household (e.g., landholding size, number of cattle, goats, poultry, sheep, and agricultural tools), number of months that a household has maize from its own harvest, housing qualityand access to inputs. Other criteria were annual crop yields, influence within society, income level, and type of house. Using these, farmers came up with four wealth classes: the richest, the rich, the poor, and the poorest (Table 4). The percentage of farmers in each group was calculated by asking them to mark with a stone the class he or she belonged to. All groups ranked land ownership as the most important defining characteristic in the study areas.

Roles of farmer classes within society

Further discussions focused on the characteristics of each class. There were few differences in how the farmers were classified between sites. Farmers pointed out that the well being of farming households centered on agricultural production. For example, Chisepo farmers said that the liberalization of tobacco growing enabled some households to move to a higher wealth category. The problem with growing tobacco, however, is that it requires a lot of fertilizer, which the majority of farmers fail to buy. However, farmers were quick to say that their hopes were now resting on soil fertility research, which would enable them to grow tobacco as well as maize. In Songani, farmers highlighted the importance of crop production to their well being. They pointed out that the intercropping of pigeon peas and cassava in their maize fields has given them the opportunity to sell the crops to the municipality market, ADMARC, and private traders such as Rab Processors Ltd. This has also enabled some households to move to a higher wealth category. Farmers from both sites also mentioned that some households have either remained static or moved to a lower category due to a lack of resources or the death of household heads.

The richest farmers. The richest farmers have almost everything needed to support their families. They have enough food to eat well throughout the year, enough farm tools and livestock, iron-roofed houses, enough land, and were able to afford fertilizers and to hire labor. They are able to sell their crops after harvest. They have enough resources to invest in the manner they choose. This group was reported to be very influential in making decisions that affect the whole society. The richest farmers assist the poor by hiring their labor for cash or in-kind payments and also by providing resources for social gatherings. The number of well-to-do farmers in the village is important because it indicates how advanced the village is.

The richest farmers are often admired by other farmers in the villages. They take risks, especially when it comes to trying new crop varieties or technologies (Ng'ong'ola et al. 1992), because of their resource endowment. This means that they are the first adopters of technologies that give promising returns. On the other hand, however, richer farmers can pose a big problem to society, depending on their behavior. It is easy for such farmers to boast about their wealth. Furthermore, since they also have superior access to resources, it is easy for them to develop a sense of monopoly, especially over resources that are meant to benefit the community. In Chisepo, farmers said the best soils were the *Katondo* and upland sandy loams, most of which are owned by the richest farmers. The crops they grow are maize (for food), tobacco (for sale), groundnuts (for sale), and paprika (for sale). In Songani the most common soils are the sandy loams and the sandy soils. These soils are used for the production of maize, cassava, groundnuts, and beans. Richer farmers are able to spread the effects of risk by diversifying their resource use. The only differences observed between the study areas in this category were that farmers in Chisepo grow tobacco, which probably makes them richer once the harvest is sold, and they also have cattle and oxcarts for transportation.

Table 4. Common farmer classes and classification criteria in Chisepo and Songani, Malawi.

	Chisepo		Songani	
Class	**Criteria**	**Proportion of households (%)**	**Criteria**	**Proportion of households (%)**
Richest	Always harvest a lot of maize and other crops. Grow good tobacco. Cattle, goats, poultry. >6 ha of land. Always buy fertilizer. Oxcarts and enough hoes. Iron-roofed houses. Eat well.	3	Enough maize stocks. Enough land. Goats and sheep Always buy enough fertilizer. Iron-roofed houses. Hire labor. Find money easily. Some own grocery shops.	4
Rich	Some have small businesses. Radios. Enough food. Well thatched grass-roofed houses. Cattle and goats. Just enough garden area. Can afford to hire in labor.	7	Food year round. Iron-roofed houses without cement floors. Bicycles. Enough clothes. Businesses. Small pieces of land. Hire out casual labor.	11
Poor	Unthatched houses with mud walls. One to two small pieces of land. Hire out casual labor. Do not harvest enough. Lack fertilizers. Grow vegetables to sell. Chickens. Not enough clothes.	37	Small gardens. Sell firewood. Not enough food. Seek piecework for food and cash. Do not buy fertilizer. Few farm tools. No radios. No livestock, only a few chickens.	37
Poorest	One set of clothes at a time. No food, but eat maize bran. Vulnerable to diseases. Malnourished children. Can't buy fertilizer. One piece of land.	53	Rely on casual labor for food. Beggars. Houses that leak. Malnourished children. No proper bedding. No adequate food.	48

Rich farmers. The rich farmers have enough to support their households. They have good houses, some small businesses, radios, enough land and food, and can afford to hire labor and buy fertilizer. They have resources to keep them at a break-even point and to provide meals for their households throughout the year. These farmers are able to sell their crop surplus but tend to keep it until they are confident of the next crop in the field. They are able to hire labor using cash or in-kind payments. They are able to grow and fertilize tobacco for sale, maize for food and sale, and groundnuts for food and sale. In Songani these farmers largely produce cassava to sell to ADMARC and private traders. Their roles in society are more less the same as those of the richest farmers.

The poor and very poor farmers. These farmers just break even most of their lives. They have poor access to agricultural resources, hence their production and productivity are low. The main crops grown by these groups are maize (using mostly local or recycled hybrid seeds and little or no fertilizer), sweet potatoes, pumpkins, groundnuts, and beans. The harvest from these crops is not enough but farmers sell some to meet other immediate cash needs. Most poor farmers have cultivated their fields for a long time without improving soil fertility. Due to their meager resources, they have to work for richer farmers to survive. The main disadvantage of being a poor or very poor farmer is that they spend a lot of time hiring out labor and very little time in their own fields. The "poorest" farmers were the strugglers. Their land holdings are small, they harvest little, rely on casual labor, use no fertilizer, live in poor houses, and have malnourished children. They have few farm tools and sell their labor to survive. Because they are perpetually without adequate food reserves, it is difficult for them to improve their situation. Helping these farmers through credit schemes may enable them to graduate to a higher well-being class.

Table 5 shows the distribution of some characteristics of farmers from Chisepo and Songani. Land availability was a key characteristic across the study area. Most farmers in Songani said they had land problems, as indicated by the high percentage (68%) of farmers with less than 1 ha of land. Few farmers (7%) had enough land. Farmers in both areas also reported soil infertility to be a common problem. Earlier studies in the Songani catchment showed that aside from landholding size, soil infertility was the main issue (Kamangira et al. 1997; Kanyama-Phiri et al. 1998; Whiteside and Carr 1997). In Chisepo most farmers had 1 ha of land or more. Farmers reported that some poor households had large amounts of land inherited from parents that they were not able to develop due to a lack of resources. This suggests that the amount of land owned is not the most accurate indicator of wealth among farmers; instead, the criterion should relate to how well the land is used.

Livestock ownership was another criterion used in the ranking exercise. Poultry, goats, and sheep dominate the animal industry in Songani. No cattle were reported in the area. The richest and rich farmers owned goats, sheep, and poultry. Chisepo farmers

Table 5. Criteria used in the stratification of farmers in Chisepo and Songani, Malawi.

Variable	Chisepo (% households)	Songani (% households)
Landholding size (ha)		
<1	9.0	68.0
1-2	46.0	25.0
>2	45.0	7.0
Livestock ownership		
Cattle	7.0	0.0
Goats	38.4	22.8
Sheep	11.4	20.3
Poultry	53.1	55.7
Pigs	2.0	1.3
Maize provision ability[1] (months)		
0-3	2.0	4.8
4-6	26.5	21.1
7-9	43.2	57.1
10-12	28.3	17.0

[1] Number of months after maize harvest during which maize was available in household stocks.
Source: Kamanga (1999); Snapp et al. (1999).

had some cattle and more goats and pigs than Songani farmers, but less sheep. Livestock availability could indicate some level of manure use in farmers' fields; however, this practice was not common among many farmers in the study area.

Maize provision ability (MPA) was another criterion used to stratify farmers in the study area. This term indicates the length of time that the farmer has maize; i.e., the time from maize harvest to when a household depletes its stock (Orr et al. 1997). This period depends on how much maize a household has harvested and how many months it lasts. Farmers who had maize throughout the season were considered richest or rich, while those that had no maize from harvest were classified as poor or poorest. The food security situation in Chisepo was relatively better than in Songani. In Chisepo, 28% of farmers had maize throughout the year compared to only 17% of farmers in Songani.

Farmer Classification of Soil Types

Soil classification delineates one soil from another based on properties such as color, feel, and moisture retention (Kamangira 1997). Farmers classify soils according to crops or plants grown in the area, color, and how well they take up water (Young 1987). The classification in this study was conducted to create an inventory and description of Chisepo and Songani soils. The exercise involved discussions with farmers about soil units and boundaries and physical characteristics of the different soils. Farmers started by naming the soils prevalent in their areas. The classification criteria were then outlined. These included color, water-holding capacity, workability, feel, existing trees and grasses, and presence of small stones. Each soil type was discussed in terms of its characteristics, the crops growing well on it, and its management. These classes were recorded on the chart and farmers were asked to put a stone in each class that represented the soil type occurring in each of their fields. The stones were used to calculate the percentages of farmers with fields in each soil class. Transect walks were also conducted to crosscheck farmers' classifications.

In both Chisepo and Songani, farmers classified soils using visual characteristics such as color, particle size, and the type of plants growing on them. Black, reddish, and whitish soils were identified. Black soil is more common in the *dambo*s (wetlands). Farmers said these were fertile soils used for dry season planting. The red soils are quite common in Songani and a few were reported in Chisepo. In both areas these soils are found in relatively higher areas. Most of the soils used for agricultural production in Songani are red, while in Chisepo they are whitish-grey. This farmer-based classification is a broad one.

The Malawi Soil Classification defines soils based on nutrient content, cation exchange capacity (CEC), water holding capacity, color, and structure (Lowole 1995; Young and Brown 1962). Farmers from Chisepo and Songani combined some of these criteria with those mentioned above to classify their soils. A comparison of the farmer-derived soil classification and the Malawi Soil Classification is made in Table 6. As expected, farmers were not able to comment on pH, structure, CEC, and level of nutrients such as phosphorus and potassium.

Table 7 shows farmers' scoring of their fields and soil types. Using a flip chart, farmers were asked to place a stone on the class that his/her field belonged to. The percentages were calculated from the total number of fields and farmers available. Scoring revealed that there are two main classes of soils in both sites: most farmers have fields in the sandy soils (*Mchenga*) and many have fields in the sandy loamy soils (*Katondo*). *Mchenga* and *Katondo* are mostly used for agricultural production because they are the most common (Coote et al. 1998). In Chisepo, farmers learnt that the CG7 groundnut variety is good for rotation and intercropping with maize, and that benefits are seen

Table 6. Comparison of the soil classification developed by farmers in Chisepo and Songani, Malawi.

	Farmer classification				
Name	Characteristics	Crops and uses	Catena position	Management	Malawi Soil Classification
Katondo	Reddish with medium-sized particles. Does not easily wet. Difficult to work with when wet, sticks to implements. Hard when dry. Fertile. Needs a lot of rain. Dries faster.	Maize, groundnuts, beans, sorghum, and pigeon peas grow well. House construction. Brick making. Priority soil type for fertilizer application by rich farmers.	Upper *dambo* margins (0–12% slope).	Plant with first rains. Small ridges because soil does not easily waterlog. Little or no banking to avoid termites. Basal and topdress fertilizer. Composting (very little). Crop residue incorporation, especially in Songani. Rotation with groundnuts, especially CG7, has proved useful in Chisepo.	Ferruginous soils/ ferric rhodustalf. Dark red with strong structure. Sandy clay loam top soil. pH 5.3-6.7. Low cation exchange capacity (CEC) (5.44 cmol/kg soil). Low available P. Most productive.
Mchenga	Whitish with coarse particles. Needs a lot of rain. Absorbs water easily. Non sticky. Dries faster.	Most crops, mainly tobacco. Fertilizer application is a priority for tobacco growing. House construction	Lower margins to *dambo* valleys.	Bunds. Manure. Farmers prefer using 23:21:0+4 and urea or a mixture. Farmers suggest that pigeon peas could be best intercropped in this soil type.	Sandy ferrallitic soils Sandy or loamy texture. pH 4.9-6.0. Low organic matter. Low water holding capacity. Leachable.
Mtsilo	Blackish with fine particles. Fertile. Sticky. Requires average rainfall. Holds water. Slippery.	Wetland cultivation is very important for growing an early maize crop. Used by nurseries for growing tobacco and trees.	*Dambo* valleys (0–12% slope).	Early planting. Early weeding. Little fertilizer.	Hydromorphic soils. Impeded drainage. Medium-high CEC. High nutrient content Sandy clay loam. High water holding capacity.
Sangalabwe	Reddish with small stone particles. Holds water. Difficult to work with when wet. Not fertile.	Road gravel. Plantations.	Upper *dambo* margins.	Grazing area. Contour bunds if cultivated.	Lithosols. Shallow and stony. 30-50 cm deep.
Makande	Blackish with smaller particles. Fertile. Cracks when dry. Holds water.	Most arable crops, sugar cane, rice Shallow wells for villages.	Lower *dambo* valleys.	Drains. Manure. Dry season grazing.	Vertisols. Hydromophic soils. Very deep. Montmorillonitic clays, which shrink when dry. Low hydraulic conductivity. pH 6.6-8.2. High CEC. High organic matter. Swell and sticky.
Chikungu	Greyish and medium particles. Keeps water. Infertile. Salty (animals lick it).	Sugarcane.	Lower *dambo* margins.	Grazing.	Hydromorphic soils. Salty. High CEC. Sandy clay. pH 6.9-7.5.
Nyata	Anthill soils. Very fertile. Sticky when wet and difficult to work with. Absorbs water slowly and cracks when dry.	Most arable crops.	All positions.	Used for *dimba* gardens in *dambos*.	Varying characteristics, which depend on location of anthill, but normally fertile and sticky.

Table 7. Soil types used by farmers in Chisepo and Songani, Malawi.

	Chisepo		Songani	
	%	%	%	%
Soil type	fields	farmers	fields	farmers
Katondo	23	23	20	26
Mchenga	71	67	64	59
Makande	3	6	6	9
Mtsilo	1	3	2	2
Sangalabwe	2	1	8	4

more in the *Katondo* soils than in the *Mchenga*. They also learnt that pigeon peas do well as an intercrop in *Mchenga* soils. *Katondo* is the priority soil type for maize in Chisepo, while *Mchenga* is the priority soil type for tobacco. *Mtsilo* and *Makande* soils are very fertile but are rare and difficult to work with—they waterlog easily and crack when dry. However, wetland cultivation in these soils is very important to most farmers—farmers noted that *dimba* (wetland) fields gave them an early maize crop in about December when maize stocks were finished. Also, tobacco farmers establish nurseries in these soil types. Most of the *dambo*s are left for animal grazing in Chisepo, while in Songani the wetlands are fully utilized for growing vegetables, sugarcane, rice, and bananas throughout the year.

Farmer Classification of Crop Seasons

Malawi has one climatic zone with two seasons, wet and dry. Classification of the seasons depends on rainfall (amount, annual distribution, and timing) and associated winds, droughts, and floods. Farmers in both Chisepo and Songani used rainfall as the main criterion for classifying the seasons, focusing on when the rain started and finished and how much fell each season. These factors reflect the crop yield expected each year. In the study, farmers recalled and classified each year from 1980 to 1999 according to whether it was a drought year or not. Farmers also discussed their field management practices during drought years in terms of fertilizer application, type of crops planted, weeding, planting, and whether they harvested enough. Seasons were broadly described as “bad” or “good”. In a good season, rains started early (in October) and were evenly distributed throughout the season; there were no strong winds, crop diseases, or pests; and farm activities progressed smoothly, resulting in high crop yields. A bad season was late to start, had an uneven rainfall distribution, long mid-season droughts, and low yields. An average season was characterized by intermediate conditions. Table 8 lists the characteristics and management practices associated with these seasons.

Farmers at both sites were able to recall the nature of a season over a period of 20 years (Table 9). Results showed that the frequency of drought was low and that crop yield was dependent on the type of season.

Table 8. Classification of crop seasons by farmers in Chisepo and Songani, Malawi.

Season	Characteristics	Management practices
Good	Enough rainfall at planting and tasseling. Rain starts in November and ends in April. Rain distributed evenly at planting and tasseling. Enough sunshine hours for maximum crop growth No strong winds associated with drought. Gentle southerly winds associated with good rains. Uniform crop germination, growth, and high yield. Reduced diseases and pests such as army worms and stalkborer.	Timely planting, weeding, fertilizing, banking, and harvesting.
Bad	Rains start late. Poor rainfall at planting and flowering. Poor distribution with many dry spells. Excessive rainfall causing flooding and waterlogging. Too much rain, even after the maize is mature. Cold, strong winds. Excessively long sunshine hours.	Dry planting sometimes undertaken. Big ridges to reduce waterlogging. Delayed weeding and fertilizing. Split fertilizer application. Box ridges to capture water. Most crops planted in *dambo*s in cases of excessive rainfall.

Summary

Farmer types and soil classes play significant roles in determining farmers' production levels. For example, a poor farmer has very little influence over increasing crop production through the use of inorganic fertilizers, while a poor soil gives very little support to crop growth. When developing agricultural technologies with farmers, it is important to know the farmers and soils being targeted to maximize the relevance and, hence, adoption of the technologies.

Diagnosing farmers' cropping systems improves the understanding of the farming environment. It describes how different farmer classes influence certain cropping patterns. For example, farmers with small landholdings are compelled to intercrop, while those with enough land can afford to grow each crop separately. Therefore, technologies not well suited to intercropping systems may be better targeted for farmers who have larger landholdings.

Part III: Systems Diagnosis--Preliminary Description

The smallholder agricultural farm is a complex and dynamic unit in which many processes interact naturally or through the farmer's influence. A farmer is a good experimenter who learns from experience and implements changes based on personal judgement. A farmer responds to the agricultural environment in many ways, one of which is to modify farming practices in response to the environment. For example, in a bad season, a farmer will increase the range of crops grown to minimize risk. Modifications made by the farmer are very important to agricultural research and development. Not only are farmers' knowledge and experience very useful in the development of new technologies; farmers also gain a sense of ownership of the technologies by having input into the process. The objective of this work is to understand and document how farming systems affect

Table 9. Frequency of good, bad, and average seasons over a 20-year period in Chisepo and Songani, Malawi.

	Rainfall pattern				
Year	Good	Bad	Average	Yield level	Characteristics
2000			√	Average maize yields	Rainfall stopped prematurely
1999	√			Good harvest, especially maize	Enough rainfall
1998	√			Good yields	Enough rainfall but late start
1997	√			Good crop	Good rainfall despite late start
1996	√			Good crop	Good rainfall
1995	√			Good crop	Early start of rains
1994			√	Average crop yields	Average rainfall
1993		√		Poor maize	Inadequate rainfall, drought year
1992			√	Poor crop yields	Poor rainfall distribution
1991	√			Good crop	Army worms when maize mature
1990	√			Good crop	Good rainfall
1989		√		Average crop harvest	Too much rainfall
1988	√			Good crop harvest	Good rainfall
1987	√			Good crop harvest	Good rainfall
1986		√		Poor crop harvest	Drought year
1985	√			Good crop harvest	Good rainfall
1984		√		Poor crop harvest	Poor rainfall distribution
1983	√			Good crop yields	Good rainfall
1982	√			Good crop harvest	Good rainfall
1981	√			Good crop yields	Good rainfall
1980	√			Good crop yields	Good rainfall

agricultural production and how farmers cope with unfavorable conditions such as droughts. This section describes farmers' systems in the study area, and includes community maps, transects, and seasonal cropping calendars.

The work described below drew on what farmers do and know. Farmers formed the main source of information for the study. Men and women were grouped separately to make sure that everyone participated fully in the discussions. The discussions were held to make farmers aware of the need for the exercise. It was agreed that farmers were to produce the community maps, farm transects, seasonal cropping calendars, and cropping patterns.

Participatory Community Mapping

A community map is a topographical representation that identifies infrastructure, existing resources, boundaries, and other physical characteristics (Selener 1999). It includes spatial distribution of homes, fields, roads, and other land resources in the area. In short it is an inventory of the community's resources. To construct the maps, the farmers discussed how the maps were to be made, what information was to be included, and the importance of the maps. After the group discussions, farmers conducted a walk around the villages. The walk provided an opportunity for the farmers to identify and discuss problems and features of the community. Farmers were separated into two groups, male and female, to ensure that everyone participated fully. Each group first drew its own map on the ground using local materials such as sticks, stones, or pieces of metal and grass, and then transferred the information to flip chart paper. Grass was used to represent crop fields and other land, while stones and metals represented buildings and other infrastructure. After the drawing stage, each group presented their map for discussion.

Figure 3. Community map of Mbingwa village, Chisepo, drawn by local farmers.

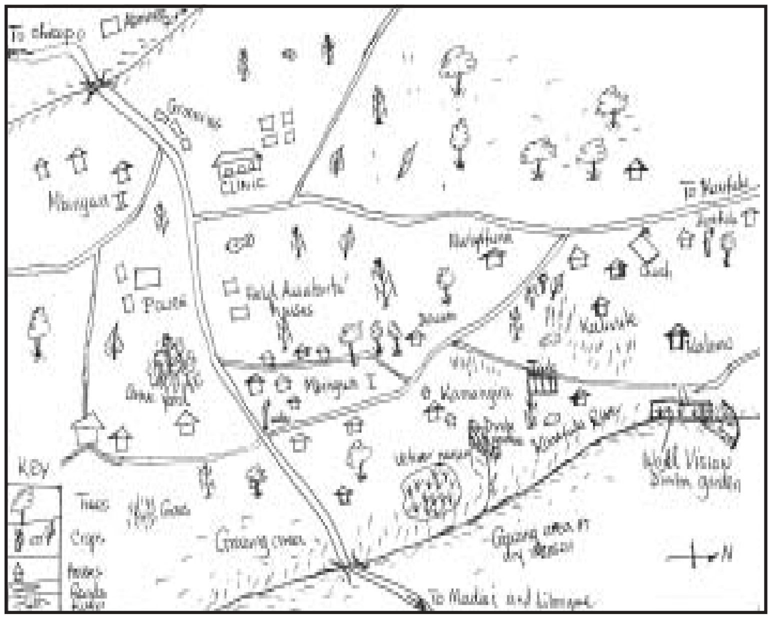
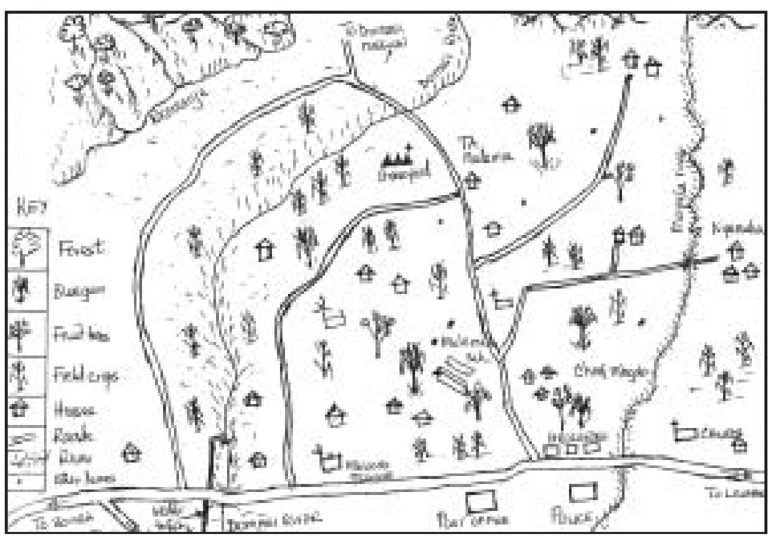


Figure 4. Community map of Malemia village, Songani, drawn by local farmers.



At the end of the exercise, farmers produced community maps for Chisepo and Songani, as shown in Figures 3 and 4. The maps show the spatial arrangement of soil types in terms of farmers' perceptions of fertile soils. In Songani, poor soils are located largely on the mountainsides and fertile soils are found in the low areas. The maps show an even pattern of field distribution over the area, despite soil type. This is expected since land pressure in the area is very high, resulting in the cultivation of marginal land. It is important to determine whether cultivating this land is sustainable or not. If it is not, agricultural technologies developed with local farmer input targeted at marginal areas may help to increase productivity.

Fields in the study are subdivided between the mountain and the main road so that most households have fields in the vlei, vlei margins, topland, and homesteads. Homesteads in the study area are located near roads. It is interesting to note how a household distributes its resources across the fields. In Chisepo the lowland is largely used for grazing, while cropping fields are located in the topland. Homesteads are located on one side and fields are located on the other. Sandy soils are largely distributed from the wetlands to the middle of the topland.

Participatory Transect Walks

Farmers conducted a guided transect walk employing procedures described by Molnar (1989). A farm transect is an imaginary topographical cut or cross section of a farm made to identify various agricultural-related factors. The transects were established using permanent natural features: in Songani they were laid from the lower area to the mountainside, while in Chisepo they were laid from the upper topland to the lower *dambo* area. The information to be noted included soil types and management, crops and cropping patterns, slope, trees, infrastructure, livestock, and any relevant problems and solutions. Farmers were asked to choose the transects that they thought covered a diverse range of the issues to be included. The walk was conducted along the transect through several fields to observe important features. Comments from farmers were recorded throughout the walk. Afterwards, farmers reproduced the transect on paper. The transects produced by farmers in the study area are presented in Figures 5 and 6. The figures show soil types, crops and cropping patterns, homesteads, and trees and other natural resources in each area.

In Songani the slope of the land varies from 0% to over 12%. The land between the main road and the mountain is extensively cultivated, with many farmers cultivating the wetlands. The common cropping pattern in the area is maize intercropped with pigeon peas, cassava, groundnuts, and pumpkins. It was also observed that farmers have implemented soil- and water-conserving measures, especially in fields on the mountainsides where erosion is common. Pigeon peas are largely grown for food but 96% of farmers now incorporate crop residues since realizing the soil improvement benefits (Peter and Herera 1989; Kamangira 1997). The *dambos* are planted to maize and vegetables in the dry season, patches of rice in the rainy season, and perennial crops such as sugarcane and bananas.

In Chisepo the transect revealed that most of the land on either side of the *dambos* is used for grazing livestock such as cattle and goats. Cropping fields are located in the vlei margins and topland. The reddish *Katondo* soils are regarded as fertile soils and occur in the gentle slopes of the upland. Most of the maize and groundnuts are grown in this soil. Maize is grown with crops such as beans, pumpkins, and cucumbers. Groundnuts are grown mainly as a single crop, but are also intercropped with sweet sorghum.Tobacco, the main cash crop, is grown mostly in the sandy loams in the vlei margins. There are few homestead fields in Chisepo.

Figure 5. Map of farm transect in Mbingwa village, Chisepo, drawn by local farmers.

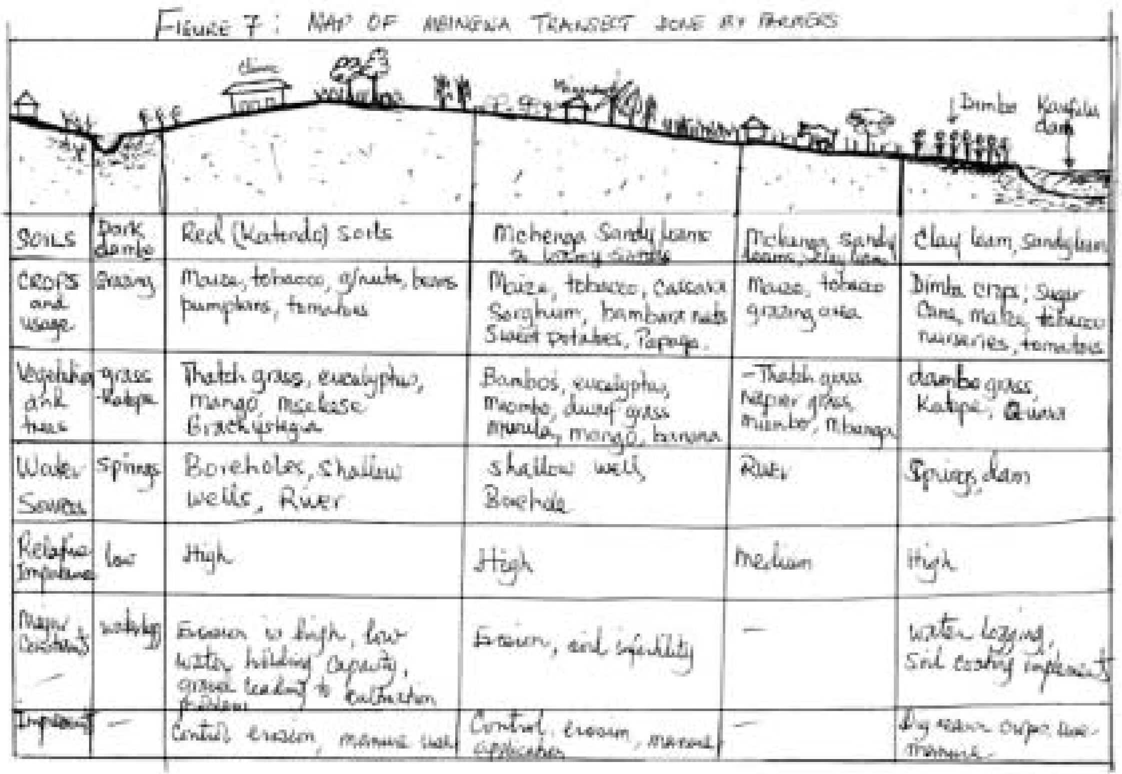
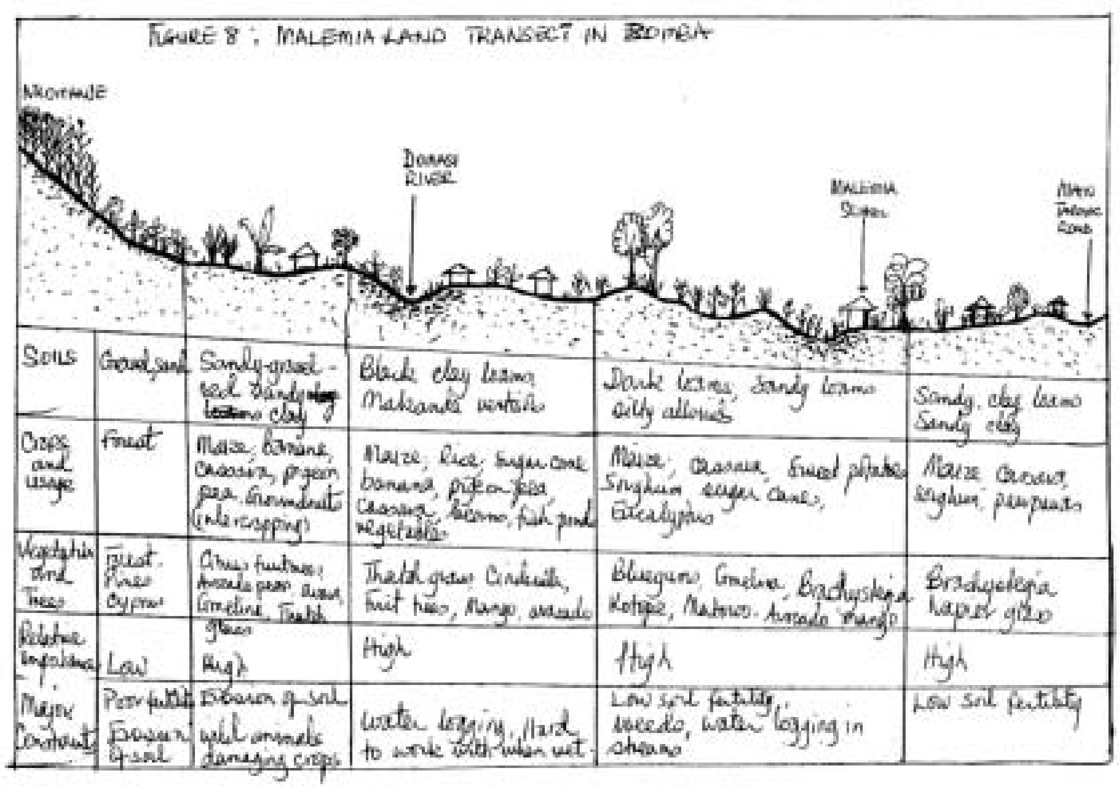


Figure 6. Map of farm transect in Malemia village, Songani, drawn by local farmers.



Seasonal Cropping Calendars

The next exercise was to produce seasonal cropping and labor calendars. Farming is a continual process governed by seasonal variation in activities. These variations are brought about through decisions made by the farmers as the season progresses. Seasonal calendar analysis is a graphical representation of seasonal activities on a farm during the year (Selener et al. 1999). They help to show patterns of labor distribution and activities during the year, opportunities for new ideas, and difficulties that could arise from adding or removing activities. A mixed group of male and female farmers was used to produce the calendars. The information recorded included farm activities, major crop planting dates and duration, patterns of labor distribution, and processing times. A large table was drawn up with columns representing months and rows representing activities. Farmers recorded their activities against each month. Seasonal calendars for Chisepo and Songani are shown in Tables 10 and 11, respectively. There are few differences in farming activities between the two areas. In Chisepo, picking and processing tobacco takes most of the farmer's time. This is a crucial production stage and requires most attention. At the same time, however, other crops need weeding, fertilizing, and bunding. Therefore, careful planning of the available labor resource and time is required. In Songani tobacco is rarely grown, hence competition for labor is spread among other crops. Furthermore, 81% of households in Songani have no maize by December (Kamanga 1999) and therefore have to sell labor to survive. This sequence of events has probably contributed to the emergence of the maize-based intercropping system in the area.

The importance of the cropping calendar lies in planning for legume technology development with farmers. For example, mucuna is a very important crop in the study area but it is unlikely that farmers will plant it as a single crop due to land shortages (Orr et al 1997). It is interplanted at low population densities with maize to minimize its spreading and shading effects. In developing mucuna technology, time of planting, its spreading effects, and its benefits to the farmer all need to be considered. Pigeon peas, on the other hand, are planted at the same time as maize. Furthermore, farmers said that there is little effect on labor requirements when maize and pigeon pea seeds are mixed and planted. Additional labor is only required when farmers want to interplant pigeon peas in a defined pattern in a maize crop, since this requires planting at separate times. The only other task is harvesting, which occurs in July. The shaded areas indicate the crop labor requirements: the darker the shading, the more labor required.

Table 10. Seasonal cropping calendar for Chisepo, Malawi.

Crops	June	July	August	September	October	November	December	January	February	March	April	May
Maize	Harvesting		Clearing and ridging	Planting *dimba* Clearing and ridging		Planting, weeding, and fertilizing (1)		Fertilizing (2) and weeding (2)	Weeding (2) and bunding			Harvesting
Groundnuts		Harvesting and clearing				Planting		Weeding				
Tobacco				Nursery activities		Planting, fertilizing (1) and (2), weeding (1), and bunding			Picking, processing, and uprooting stems			Clearing
Sweet potatoes	Harvesting							Planting				
Chickpeas						Planting					Harvesting	
Beans						Planting					Harvesting	

Table 11. Seasonal cropping calendar for Songani, Malawi.

Crops	June	July	August	September	October	November	December	January	February	March	April	May
Maize	Incorporation of residues (clearing)		Incorporation of residues and ridging			Ridging, planting, weeding (1), and fertilizing (1)		Weeding (2) and fertilizing (2)	Weeding (2) and bunding	Harvesting		
Groundnuts	Harvesting and clearing					Planting		Weeding				Harvesting
Pigeon peas			Harvesting			Planting and weeding		Weeding				
Cassava			Planting and ridging									
Sweet potatoes	Harvesting							Planting				
Mucuna						Planting at low population densities					Harvesting	
Chick peas						Planting						Harvesting
Beans						Planting				Harvesting		

Crop production

Farmers from both sites reported an increase in the diversity of crops grown including maize, groundnuts, beans, sweet potatoes, soybeans, tobacco, pumpkins, vegetables (tomato, rape, Chinese cabbage, etc), and bananas. In Songani, pigeon peas and cassava are important crops. Ninety-six percent of Songani farmers practice maize-based intercropping (Kamangira 1997), whereas this practice is not common in Chisepo. Land shortage was reported to be the most important factor influencing intercropping in Songani (Kanyama-Phiri et al. 1995; Government of Malawi 1980; Becker 1990). Crop rotation is not common in the area. Farmers continuously cultivate one piece of land (Snapp 1998), consequently, depletion of soil fertility is high. Replenishing soil fertility in these fields would be possible if modern methods of agricultural production were followed. In Songani the common cropping patterns are maize/cassava, maize/pigeon peas, maize/groundnuts, maize/soybeans, maize/cassava/pigeon peas/pumpkin, maize/pigeon peas/sorghum, maize/pigeon peas/groundnut, maize/cassava/pigeon peas, maize alone (minimal), maize/sorghum, maize/beans, and maize/groundnuts/beans.

Farmers in Chisepo have more land than those in Songani and are thus able to easily practice crop rotation (Snapp et al. 1999). Cropping systems in Chisepo differ from those in Songani in that most crops are not intercropped. In the few cases where maize is intercropped, it is grown with groundnuts (at low planting density), cucumbers, and pumpkins. Tobacco, however, is commonly intercropped with pumpkins and cucumbers. Sweet potatoes are planted on the boundaries of the main fields.

Knowledge of cropping patterns helps to identify the most suitable legume crop for an area. For example, in Chisepo, mucuna has the potential to improve fallows, whereas this is not true for Songani due to limited land area. In Songani, pigeon peas are considered to have great potential for improving fallow. This information emphasizes the need to focus on the cropping systems favored in an area when developing new technologies with farmers.

Conclusion

The information provided in this paper is based on the vast amount of knowledge and experience that farmers have with regard to their farming environments. Their detailed classification of farmers and soils and their description of crop seasons demonstrate how well they understand their environment. It is very important to incorporate local farmer wisdom when developing technologies for their environments.

Part III describes the cropping systems employed by farmers in Chisepo and Songani. These are closely linked to the classifications of farmers, soils, and cropping seasons described in Parts I and II. They identify the influence that farmer classes have on cropping systems and how different systems relate to soil classes and cropping seasons.

There is great potential for legume technology development in both Chisepo and Songani. The practice of incorporating crop residue is a good starting point for improved green manure use, and the practice of intercropping pigeon peas only needs further work on optimum plant population for adequate grain and biomass yields. Technology development for these areas should concentrate on introducing crops that are suited to the current farming systems in terms of land availability, labor, and other resource inputs.

Acknowledgements

This work was made possible through the support from CIMMYT's Risk Management Project (RMP) and Soil Fertility Management and Policy Network for Maize-Based Farming Systems in southern Africa (SFMPNET). The SFMPNET provided funding for the initial implementation of the legume project in Chisepo, while the RMP worked alongside farmers to further develop the technologies. Finally, we thank contract editor Jane Reeves, CIMMYT writer Mike Listman, and CIMMYT designer Wenceslao Almazán for their help in getting this paper to publication.

References

Adjei-Twum, D.C., A.A. Likoswe, and H.N. Soko. 1993. Studies of mixtures of pigeon peas and maize to intercropping with special reference to the proportion of the component crop. FAO project DP/MLW/88/039 field document. Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP).

Banda, A.Z., J.A. Maghembe, D.N. Ngugi, and V.A. Chombe. 1994. Effect of intercropping maize and spaced leucaena hedgerows on soil conservation and yield on steep slopes at Ntcheu, Malawi. *Agroforestry Systems* 27:17-22.

Becker, H. 1990. Labour input decisions of subsistence farm households in southern Malawi. *Journal of Agricultural Economics* 41:162-171.

Bellon, M.R. 1999. Farmer participatory methods for soil fertility research. CIMMYT Economics Working Paper No. 4. Mexico, D.F.: CIMMYT.

Benson, T.D. 1997. Spatial and temporal variation in fertilizer recommendations for maize grown by smallholders in Malawi. In: *Maize Commodity Team Annual Report*, pp. 135-144. Ministry of Agriculture, Department of Agriculture Research, Chitedze Research Station, Lilongwe Malawi.

Biggs, S.D. 1989. Resource-poor farmers' participation in research. A synthesis of experience from nine national agricultural research systems. OFCOR Comprehensive Study Paper No. 3. The Hague, The Netherlands: International Services for National Agricultural Research (ISNAR).

Bjornson, B., and R. Innes. 1992. Another look at returns to agricultural and nonagricultural assets *American Journal of Agricultural Economics* 74:109-118.

Brummett, R.E., and F.J.K Chikafumbwa. 1999. An incremental farmer participatory approach to the development of aquaculture technology in Malawi. A discussion paper. Zomba, Malawi: International Center for Living Aquatic Resources Management (ICLARM).

Coote, C., K. Giller, A. Sutherland, S. Mughogho, T. Benson, N. Oudwater, and J. Counter. 1998. Soil fertility in Malawi: A review of policies, productivity and perceptions. A discussion paper. Chatham, UK: Natural Resources Institute and The University of Greenwich.

Gilbert, E., and M. Smale. 1993. Measuring research impact in Africa: The case of maize in Malawi. In: P. Heisy and S.R Waddington (eds.), *Impact of On-farm Research*. Proceedings of a Network on Impacts of On-farm Research in Eastern and Southern Africa, pp. 398-416.

Government of Malawi. 1980. A farm management survey of smallholder farmers in Zomba West, Malawi Agro-Economic Survey Report No. 40. Ministry of Agriculture and Natural Resources, Planning Division, Lilongwe, Malawi.

Government of Malawi. 1995. *Economic Report 1995*. Ministry of Economic Planning and Development. Zomba, Malawi: Government Printing House.

Government of Malawi. 1996. *Economic Report 1996*. Ministry of Economic Planning and Development. Zomba, Malawi: Government Printing House.

Hardy, T. 1998. Malawi: Soil fertility issues and options. A discussion paper. Lilongwe, Malawi.

Kamanga, B.C.G. 1999. Impact of existing and introduced agroforestry tree species on maize production in Songani, Southern Malawi. MSc thesis, Department of Crop Science, Bunda College of Agriculture, Malawi.

Kamangira, J.B. 1997. Assessment of soil fertility status using conventional and participatory methods. MSc thesis, Department of Crop Science, Bunda College of Agriculture, University of Malawi.

Kanyama-Phiri, G.Y., S.S. Snapp, and S. Minae. 1998. Partnership with Malawian farmers to develop organic matter technologies. *Outlook on Agriculture* 27:167-175.

Leach, M. 1995. Ganyu labor: The implications of off farm labor for alley cropping in Malawi. Addfood Monitoring and Evaluation. Lilongwe, Malawi.

Lowole, M.W. 1995. Soils of Malawi and their inherent constraints. File D12, E2, Soil Survey Unit. Lilongwe, Malawi.

Molnar, A. 1989. *Community Forestry Rapid Appraisal*. Rome: Food and Agriculture Organization of the United Nations (FAO).

Ng'ong'ola, D.H., B.H. Mtimuni, G.Y. Kanyama-Phiri, D.W. Nothale, and K.A. Wiyo. 1992. Socio-economic forecasts for land uses in Malawi. Bunda College, Lilongwe, Malawi.

Ng'ong'ola, D.H., and J.H. Mangisoni. 1994. Production efficiency of barley estates: A case study of Kasungu Agricultural Development Division. Department of Agricultural Economics in Southern Africa. *Agricultural Economics Analysis and Rural Development* 4(2):29-53.

Peter, P.E., and M.G. Herrera. 1989. Cash cropping, food security and nutrition: The effects of agricultural commercialization among smallholder farmers in Malawi. Lilongwe, Malawi.

Ritchie, J.M., C.S.M. Chanika, J. Lawson-McDowall, A. Orr, and B. Mwale. 2000. Disseminating research results to researchers, extensionists and farmers: What have we got and how should we package it? In: J.M. Ritchie (ed.), *Integrated Crop Management Research in Malawi: Developing technologies with Farmers. Proceedings of the Final Workshop of the Farming Systems Integrated Pest Management Project*. Chatham, UK: National Resources Institute.

Sakala, W.D. 1999. Crop management interventions in traditional maize-pigeon peas intercropping systems in Malawi. MSc thesis, Bunda College of Agriculture, University of Malawi.

Selener, D. 1997. *Participatory Action Research and Social Change*. 2nd Ed. Quito, Ecuador: Global Action Publications.

Shaxson, L., and L.W. Taur. 1992. Intercropping and diversity: An economic analysis of cropping patterns on smallholder farms in Malawi. *Experimental Agriculture* 28:211-228.

Snapp, S.S. 1995. Improving fertilizer efficiency with small additions of high quality organic inputs. In: S.R. Waddington (ed.), *Report on the First Meeting of the Network for Maize-Based Farming Systems in Selected Countries of Southern Africa*, pp. 60-65. The Rockefeller Foundation, Southern Africa Agricultural Sciences Programme, and CIMMYT, Zimbabwe.

Snapp, S.S. 1998. Soil nutrient status of smallholder farms in Malawi. *Communications in Soil Science and Plant Analysis* 29:2571-2588.

Snapp, S.S., B.C.G. Kamanga, and F. Simtowe. 1999. Soil fertility options for Malawi smallholders: Integrated legume systems. In: J.M. Ritchie (ed.), *Integrated Crop Management Research in Malawi: Developing technologies with Farmers. Proceedings of the Final workshop of the Farming Systems Integrated Pest Management Project*. Chatham, UK: National Resources Institute.

Thrupp, L.A. 1989. Legitimizing local knowledge: From displacement to empowerment for the third world people. In: *Agriculture and Human Values, Humanities and Agriculture Program*, No. 6, pp. 13-24. University of Florida, USA.

Wellard, K. 1996. Official wisdom and rural people's knowledge: environmental change in Southern Malawi. Final Report Project R5907. London, U.K.: Economic and Social Committee for Overseas Research, Overseas Development Administration.

Wendt, J.W. 1993. Evaluation of Mehlich-3 extraction for upland Malawi soils. Chitedze Research Station, Lilongwe, Malawi.

Wendt, J.W., R.B. Jones, and O.A. Itimu. 1994. An integrated approach to soil fertility improvement in Malawi. In: E.T. Craswell and J. Simpson (eds.), S*oil Fertility and Climate Constraints in Dryland Agriculture*. ACIAR Proceedings, No. 54, pp. 74-79. Canberra, Australia: Australian Centre for International Agricultural Research (ACIAR).

Wermer, J. 1987. Crop field operation survey. Labor requirement and distribution for smallholder crops in Liwonde ADD. A discussion paper. Lilongwe, Malawi.

Whiteside, M., and S. Carr. 1997. *Encouraging Sustainable Smallholder Agriculture in Malawi*. Environment and Development Constancy Limited.

Young, A. 1987. Soil productivity, soil conservation and land evaluation. *Agroforestry Systems* 5:277-291.

Young, A., and P. Brown. 1962. The physical environment of Northern Nyasaland, with special reference to soil and agriculture. Zomba, Malawi: Government Printers.