Soils, Food and Healthy Communities:
A participatory agroecosystem approach to monitoring change in northern Malawi

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1.0 Synthesis

Food insecurity and malnutrition are major problems facing poor households in the Ekwendeni catchment area in northern Malawi. The majority of Malawian households rely on domestic agricultural production, of which maize is the primary food crop, to meet household food needs. Legume systems improve soil fertility and dietary diversification of resource-poor households.

The Primary Health Care (PHC) program of Ekwendeni Hospital initiated an Organic Matter Technology project to examine whether organic matter technologies (OMTs), such as intercropping grain legumes, can improve the household food security and nutrition of resource-poor farmers and their families. The role of Soils, Food and Healthy Communities (SFHC) is to coordinate the project activities to the partners, donors and consultants, to train the farmers on all research aspects, to conduct participatory evaluation on OMTs and assess local indicators of soil fertility, food security and health.

The research objectives were:
Planning Assessment and Training:

1. To develop a flexible participatory methodology that will promote the role of resource-poor households in the research process.
2. To characterize resource use, health status, and social relations of resource-poor households.

OMT Experimental Trials:

3. To evaluate various OMTs that attempt to improve household food security and dietary diversity for resource-poor households, and measure the effects of these technologies on local indicators of health and food security.

Monitoring Changes and Seeking Solutions using an Ecosystem Approach

4. To measure changes in the agroecosystem that occur due to the introduction of organic matter technologies.
5. To develop a participatory monitoring system that will enable poor households to analyse and assess the local agroecosystem from multiple perspectives.
6. To examine intra- and inter-household dynamics related to the use of OMTs.
7. To examine the linkages between food production, food consumption and health and to use an ecosystem approach to seek appropriate solution to problems encountered throughout the research process.

The methodological approach for the project was to combine quantitative, qualitative and participatory approaches to measure changes to food security and human health when new OMTs are introduced into the community. A systems approach was therefore used to examine cross-scale interactions.

The principal finding of the project was that food production improves as soil fertility improves. Soil fertility has improved in the area because of the introduction of OMTs. It is expected that food security will be addressed as more communities expand their plots. Community participation in SFHC improves positive changes in decision-making, feeding practices of young children, and organization on a community level. The health component of the project as not been fully accomplished.

2.0 Research Problem

Food security and malnutrition were major problems in the Ekwendeni catchment area. This research sought to address the soil problems in order to improve food security and health. Throughout the project, we have maintained the original research problem. However, we have changed from quantitative research to qualitative research. This was because of staff capacity, a large amount of data that had not yet been analysed, and a desire to understand the community in more depth.

3.0 Research Findings

As soil fertility improves, so too does food production, especially maize and soya beans. Data on improving health status has not yet been analysed, so no comment can be made. Nutrition education started very late (around February 2004). There has been dietary diversification and meal frequency with the introduction of OMTs.

Data collection has been done by SFHC for the 24 different research activities. Analysis is complete for agriculture information. Please see Appendix 1 (Ekwendeni Soils Report).

4.0 Fulfillment of objectives

General Objective: The general research goal has not been completely fulfilled because nutrition education started late and the anthropometry data has not yet been analysed; we are waiting for this before working on health improvement.

Objective 1: This objective was fulfilled. The Farmer Research Team (FRT) approach has been very instrumental for capacity building in the research processes. They have been able to conduct research trials on their own and give direction to other members who were joining the project. They have also been able to evaluate the findings of different research options that were given to them from the village plots to individual plots.

Objective 2: Resource-use and social relations of resource-poor households were both characterized, but health status was not. This was because of a late introduction of nutrition education and a lack of anthropometry data analysis. The community livelihoods have an influence in the adoption of organic matter technologies. At first, women in the project were unable to voice their concerns. Now, women are able to make their own decisions regarding the use of OMTs. The adoption of OMTs has been higher with women than with men. After being provided with resources, the resource-poor communities were able to use the OMTs to improve the health status of their families. This was achieved through dietary diversification and frequency of meals.

Objective 3: This objective was fulfilled. There was participatory community evaluation of the technologies that were implemented in the first and second years. It showed that some technologies were good at soil fertility improvement, while others were good both at soil fertility improvement and food security.

Objective 4: This objective was fulfilled. The changes in soil improvement have been very significant.

Objective 5: This objective was fulfilled. Farmers are monitoring the local agroecosystem.

Objective 6: This objective was not fulfilled. Household dynamics were not examined because we were not looking at individual households, rather at a large group. We had little information at the household level.

Objective 7: This objective was fulfilled. As soil fertility improves, there is more food. Communities can access that food, and consumption improves. This is directly related to health. Malnutrition is now lower because we have improved soil fertility.

5.0 Project design and implementation

This project has run from April 2001 to April 2004. Activities included coordination of consultants, soil testing, FRT and community training, surveys and questionnaires (anthropometry, agricultural and food frequency), data management, and nutrition education.

Research methods used included participatory approaches with problem-solving techniques. We also used participatory evaluation in analyzing the OMTs to see which have been effective in improving soil and nutrition. We have used surveys to see changes in health. Communities have used participatory rural appraisal (PRA) (especially the pair wise ranking) in the most effective technologies on soil fertility and food diversification. We have used wealth ranking in categorizing the communities. We have used soil testing to come up with the OMTs that were most effective in the improvement of nutrients to the soil.

The project design has not changed. For details on changes in the methodology, please see section 2.0.

Partnerships with Canadians included Rachel Bezner Kerr, Julia Krasevic, Tanya Trevors and David Ryan. Rachel was helpful in designing the project, Julia assisted with the nutrition part of the project, and Tanya helped with office management. David assisted with preliminary analysis of anthropometry data. Other researchers who worked with the project included the late Dr. Sakara, Caroline Kayira, Bernard Kamanga. We also had partnerships with PATH Canada and Presbyterian World Service & Development.

The communities involved in the project were the primary beneficiaries. They were involved in project appraisal, project design, implementation, reviewing and evaluation. The project was based on participatory approaches, so beneficiaries were very involved in all aspects of the project.

Gender issues were addressed in the project. The FRT consisted of 18 men and 12 women. The women have made a very strong contribution to the project. Initially, 49% of farmers were women; now, 72% are women. Decision-making on cropping patterns and where to cultivate is done by women. There have been fewer men joining the project recently. Women are saying that it is more beneficial to them because of the food security aspects.

Please see Appendix 2 (Timeline of the Agriculture Cycle and Major SFHC Research & Development Activities 2000-2004).

6.0 Project outputs and dissemination

Information Sharing and Dissemination

1. A report for the Ministry of Agriculture and other interested agricultural research organizations on organic matter technologies and the results of the on-farm experiments in terms of changes in the agroecosystem.

A report was written in May 2003 on OMTs and the results of the experiments and field days. It was sent to the Mzuzu Agricultural Development Division (MADD). The International Centre for Research in Semi-Arid Tropics (ICRISAT) and the International Maize and Wheat Improvement Center (Centro Internacional de Majarmiento de Maiz y Trigo - CIMMYT) also received similar reports. Please see Appendix 3 (Report on OMTs Experimental Plots).

2. At least two peer-reviewed publications of research results.

This has not been done yet. A paper was prepared for EcoHealth, and this will be published soon in a journal. Please see Appendix 4 (Ecohealth paper). In terms of full research results, the research has not yet been completed. There was also an article written for the Soil Fertility Network. Please see Appendix 5 (Article for Soil Fertility Network).

3. Improved linkages between PHC, agricultural research organizations and social science research organizations in Malawi.

Coordination and networking has occurred with PHC, Chitedze agriculture, CIMMYT, ICRISAT, MADD and the International Centre for Research in Agroforestry (ICRAF).

Knowledge Creation

4. Characterization and mapping (at farm and village level) of different resource uses within the agroecosystem in the region.

This was done through participatory mapping and PRAs.

5. Characterization of intra- and inter-household relations that influence food security, childcare and human health in the region.

This was done through focus group discussions on decision-making and a characterization of roles that are taken by different people within the community. Through these focus group discussion and gender training, women are now able to share their views.

6. Health, dietary and micronutrient status information, which can be used in other PHC programs, as well as the Ministry of Health programs for northern Malawi.

This information was gathered, and the Ministry of Health is using some of it. When the PHC conducts nutrition training at the hospital, they get some of the information from this project.

7. A participatory research method that guides the process of developing local indicators of food security, health and soil fertility from multiple perspectives within the community.

We developed indicators for food security, health and soil fertility with the communities, and a report was written. Please see Appendix 6 (Farmer Evaluation Report). We have a team that is monitoring these indicators.

8. Policy and program recommendations for health and agricultural sectors to improve food security and human health of resource-poor households.

This has not been done. The information on health and analysis has not yet been done. As a result, we did not have enough information to lobby the government.

Training

9. An FRT (20-40 farmers) with training in OMTs, trial design, research methods and action research.

A team of 30 farmers was formed in the pilot area. They are still being trained in the areas mentioned above. For the whole catchment area, the FRT consists of 118 members.

10. At least three workshops run by PHC for farmers on OMTs.

At least three workshops are conducted every year on OMT planting patterns, group dynamics, and gender and health.

11. At least three Field Days organized in the local communities and the wider Ekwendeni catchment area, which communicated the results of the OMTs.

At least three Field Days have been organized; 600 attended the first, 1800 attended the second and 2400 attended the third. It has been a very good mechanism for technology adoption.

12. Increased capacity for PHC to carry out participatory, qualitative and quantitative research using an agroecosystem approach to human health.

28 PHC team members were trained to carry out participatory research on using an agroecosystem approach to human health. A report for the hospital was also written.

7.0 Capacity Building

There has been extensive capacity building in terms of OMT of participating farmers such as training in planting patterns, group dynamics, supervision, data collection, facilitation skills and participatory research.

Some of the specific trainings for capacity building:

a) Marko Chirwa – Project Management Skills
    - Data collection and screening
    - Scientific Presentations
    - Participatory research and evaluation
    - Qualitative and quantitative research methods
b) Lizzie Shumba – Qualitative research methods
    - Supervision techniques
    - Trials and trial layout
    - Coordination at grass roots development
c) FRT members – OMT planting patterns
    - Supervision
    - Group dynamics
    - Facilitation skills
    - Participatory Evaluation
    - Gender and community dynamics

8.0 Project Management

With the research organization, it has been well-organized on the community level. Coordination with other researchers and consultants has been good; there has been collaboration and networking. SFHC has trained other PHC members to carry out the OMT, nutrition lessons and participatory methods. SFHC administration has been very good at all stages of the project.

Scientific management has not been as good. We have the basics in participatory methodologies and qualitative research, but there is very little on quantitative. Because of this, scientific management of the project has some problems, especially with analysis.

Support from IDRC has been very good. We have been advised, and the advice given has been very good for the continuation of the project.

9.0 Impact

The project has had an impact on communities in dietary diversification, crop yield, soil improvement and acquisition of seed for various crops. The communities have improved decision-making in these areas. Women are able to voice their concerns in groups of women and men.

10.0 Overall Assessment

The value of this project has been shown by the high adoption rates in the communities. The project is important because it has improved dietary diversification of the communities; this will have a much larger impact when nutrition education is implemented. Looking at the time, effort and money that have been invested in the project, it has been of value to the hospital and the community at large.

11. Recommendations

The effect on child health will be fully analysed when the nutrition education continues for some time. We want to intensify nutrition education and agriculture to continue our work and look forward to the funding of Phase II.

SOILS, FOOD AND HEALTHY COMMUNITIES PROJECT

SOIL ANALYSIS AND INTERPRETATION REPORT

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1.0. PREAMBLE

1.1. Factors influencing agriculture productivity (Soil fertility)

Critical to the development of Malawi is alleviation of poverty and eliminating food insecurity through commercialisation of agricultural production. Self-sufficiency in the production of maize, which is the staple food for the country, is the major task for the Government of Malawi because maize occupies more than 60% of the crops grown by most smallholder farmers. Equally critical is the maintenance of the fertility of most soils where that maize is being grown. It is interesting to note that more than 80 percent of the cultivated area is occupied by maize, and that there are some smallholder farmers who cultivate as much as 100 percent of the land planted to maize, either as a sole crop or inter-planted with other food crops.

Maize in general is a very demanding crop for nutrient elements. For example, the pH of the soil should most of the times be kept around 5.5-7.0. This is in view of the fact that pH values lower than 5.0 will make other elements, such as aluminium and manganese, to be very toxic. Over and above, at such low pH values, phosphorus may be fixed onto the aluminium, iron and/or manganese oxides.

Nitrogen, on the other hand, is the most deficient of all the nutrient elements in both low and high cation exchange capacity soils. In fact, even in soils where nitrogen is recorded to be medium or high, the contents of nitrogen will eventually be reduced within a very short period of time, more especially in areas where there is continuous cultivation of the land.

1.2. The Soils, Food and Healthy Project

Soils, Food and Healthy Communities are a project operating in Ekwendeni catchment area. The project is aimed at improving the health of resource poor households in the northern Malawi through participatory research project that introduces legume system and use an ecosystem approach examining the linkages between food security and health.

The nutrition status of the children in Ekwendeni catchments area is alarming such that a multidisciplinary approach was sought to reverse the sad malnutrition trend which has been taking its tore in the area. A linkage among the soils, food and health promised a feasible strategy to tackle the complex food shortage problem in the area which resulted from unsustainable agricultural activities. A flow of essential nutrition elements required for good health is believed to form a cycle from soils into the food crop and transferred to human beings before they are put back into the soil (see diagram 1). Any disturbance to this flow affects the sustainability of every aspect of the complex system.

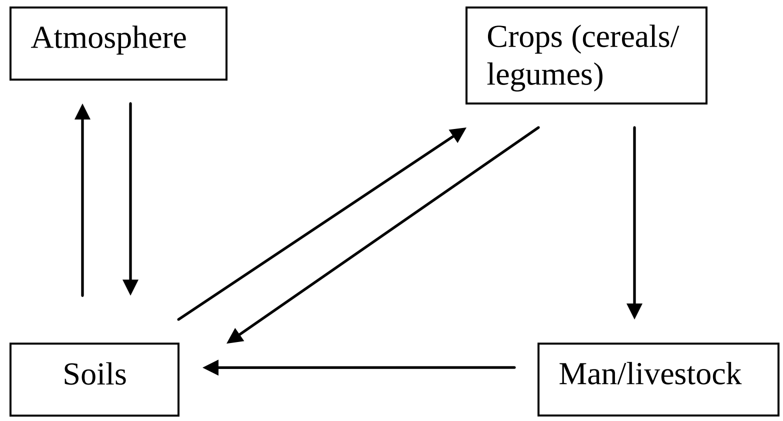

Diagram 1. The flow of nutrients and linkages on the farm level

1.3. Soil Fertility Problems

Land degradation and declining soil fertility resulting into decreasing agricultural productivity is a major problem in sub-Saharan Africa (Okigbo, 1985; Lal, 1989). Poor agronomic practices and low use of inorganic fertilizers a major characteristic of subsistence and smallholder farmers have aggravated this problem. Soils of Malawi as well as though of humid and sub-humid areas of Africa are deficient in nitrogen (Ahlawat et. al., 1981). Nitrogen is the most critical and important nutrient and required in large quantities for plant growth (Saka, 1984; Giller et. al., 1997). It plays an important role in crop nutrition as a component of chlorophyll molecule, amino acids, and enzymes. It also helps in the metabolism of carbohydrates and stimulation of root development. It influences the uptake of other nutrients, such as phosphorus and potassium (Saka, 1984).

Integration of leguminous crops into the existing maize-based cropping systems has been reported to have the potential of overcoming this problem of land degradation and declining soil fertility (Ahlawat et. al., 1981). Nitrogen fixing plants offer an economically attractive and ecologically sound means of reducing external inputs and improving internal resoiurces (Ahlawat et. al., 1981). Grain legumes such as cowpeas (Vigna unguiculata), groundnuts (Arachis hypogeae), soybean (Glycin max), Mucuna prureins and pigeon pea (Cajanus cajan) are known to have played an important role in food and animal nutrition (Mughogho et. al., 1982) making it an important factor considered in the Ekwendeni catchment areas. Leguminous cover crops are known to improve crop productivity and this augers well especially looking at the background of the low capital base of the farmers to purchase inorganic fertilizers.

Legumes have the potential to improve soil fertility thereby boosting subsequent crop yields (Mohaammed-Saleem and Otsyina, 1986; McColl, 1990a; Tarawali, 1991). They offer other benefits such as the maintenance and improvement of soil organic matter, cation exchange capacity, and microbial activity, reducing soil temperature, and suppressing weeds (Vallis and Gardner, 1984; Mohammed-Saleem and Otsyina, 1986; Mulongoy and Kang, 1986; Tarawali et. al., 1987; Akobundu, 1980, 1982)

2.0. TERMS OF REFERENCE

The consultant was required to visit the farmers' fields in order to have the field experience on the activities the farmers were participating in. This was meant to consolidate the interpretation of the quantitative data on soils, grain and stover that was taken in the previous season.

3.0. METHODOLOGICAL APPROACH

Based on the terms of reference, the consultants underwent through a series of iterative activities to come up with the expected outputs.

3.1. Farmers' Field Visits

A limited number of farmers' fields as well as village plots were visited. This was done to observe the condition on the ground on how the farmers were adopting the different low cost technologies the project was passing out. The exercise was also meant to identify the problems the farmers were missing and advise on the way forward in order to improve the adoption rates and the status of the project.

Efforts were made to interact with the farmers available at the time of the field visits. This was meant to capture the farmers' perceptions of the project and identify the gap that existed among the farmers with regard to different technologies and how these were linked to their day to day health issues. The consultant took advantage of the farmers' meeting to capture most of the issues and perceptions of the farmers on the project.

3.2. Exploration of Soils, Grain and Stover Data

The soils data was made available for exploration and scrutiny. Discussions were conducted on how best the interpretation could be handled using the available data. Summaries were to be made as basis for comparison and discussion.

3.3. Literature Review

Literature review was done in order to relate what the project is doing and research findings so as to be able to explain and back up the results being observed in the project area. The relevance of the technologies being advocated to sustainable agricultural production and promotion of human health was sought.

4.0. FINDINGS AND DISCUSSION

4.1. Farmers' Field Visits

A number of issues were discovered on the farmers' fields and diagnosis was done to analyze the extent of problems. The problems identified and the suggested remedies are as follows:

1. Some of the fields have ridges which are not aligned to the contour. Due to this erosion was quit evident and wide spread in these fields. Discussions reveal that the farmers are aware of the need of these structures in their field only that they haven't practiced. As a way forward, *it is proposed that a deliberate move be made to encourage them make marker ridges in their fields with the rest of the ridges aligned to these marker ridges.* Village plots should be used as demonstration plots thereafter the research team members follow each farmer to make sure they are applying the technology in their fields.

2. Some of the fields had very small ridges. This resulted in less foot hold for the crops. The ridges were small that they promoted accelerated loss of moisture from the field. Of much more importance is the fact that these ridges were highly prone to erosion. *It is recommended that averaged size ridges be made in order to retain the fore said attributes as well as providing enough surface area for plant nutrients extraction.*

3. Late land preparation was a common practice in this area. This was understood in the context of the farmers' past experience and practice in which case they were used to burning the crop residues. There is still a problem with adjustment and altitude change thereby promoting burning of the crop residues. *There is need to take the farmers step by step in understanding the change in practice and the importance of this change to the food security at household level and the improvement of their health status.*

4. Lack of residues incorporation as well as greatly delayed incorporation. Indications are that farmers are not really sure of the benefits of residues incorporation. This was inferred at the farmers' meeting. *There is need for refresher course. Emphasis should be made on the incorporation of residues for sustainable agricultural systems. Elements of farmers' interests on the legumes offered by the project for food and sale and not the goal of the project should be understood in order to propel the goals of the project.*

5. The village plots were found not well cared for because of lack of corporation. There is divergence in principle between the Research Team members and the Village committee. The borne of contention being the monthly fee the research team members receive. *There is need for group dynamics course for the committees and fore front and key persons in the society (project area) in order to get back the project on the right foot.*

6. Problems of agronomic procedures and technical know how were identified in some fields. Ridge spacing, plant spacing, the number of seeds per planting station were the major problem. Some farmers were even planting pigeon pea and maize on the same planting station thereby promoting high competition for growth factors. *There is need for awareness campaigns on the recommended agronomic practices. The village plots could serve as the demonstration plots and follow up be done on individual farm level to make sure that the principle learned are being practiced.*

7. It was observed that the new and 2 year old farmers were relatively doing better than old ones (3 yrs). *There is need to trace the reason behind this development and effect of this on the sustainability of the technologies the project is advancing on the villages (when the project phase out).*

8. Weeding problem was observed in some of the fields. This promotes competition of crops and weeds for growth factors eventually negatively affect the levels and quality of crop yields. *Clearly discuss the importance of weeding to the farmers in the refresher course and keep the village plots free of weeds to impress on the farmers as model.*

9. Shading effect was highlighted from some farmers especially with pigeon pea. *There is need to teach the farmers the better methods of farming with respect to spacing, and sequence of planting the different components in their fields.*

10. Some farmers were not incorporating maize residues because they were waiting for the pigeon pea biomass to be ready. *Advise farmers to incorporate immediately the maize residues soon after harvest when it is moist. Do not wait for the pigeon pea since by that time the pigeon pea is ready the soils will be dry. The defoliates of pigeon pea will be taken care of as they drop.*

11. It was observed that good crop stands were on big ridges than the smaller ridges. This was accredited to the extended periods of water reserves in the soil on big ridges. There was also enough room for root proliferation as compared to the small ridges thereby extending the zone of nutrient extraction and many more factors.

4.2. Exploration of Soils, Grain and Stover Data

The data was explored and a better representation was sort. Unfortunately a lot of gaps were identified in the presentation of the data. Incomplete sets of data were the major characteristic (see appendix 1). It was observed that in some cases only soils data was presented, while grain and stover data was missing. Similarly, data on grain and stover could be presented while soils data is missing. Due to this short fall, no attempt was made to go into nutrient balance sheets. This requires that the team should be more careful next time it goes for soils, grain and stover sampling so as to take a representative data on which conclusions could easily be made.

Nonetheless, an attempt was made to give the general picture and trend of the technologies impact in the different areas. The following section gives an account of the situation.

4.2.1. pH

Observation of the pH data and comparison with that taken earlier on indicates that there are no significant shifts in all the villages and across the treatments. They were all slightly acid and favorable to the development of almost all the crops involved in the project. They ranged from 6.5 to 5.4. No limitations are highlighted which could result from these levels of pH on the crops involved in the project.

4.2.2. Phosphorus (P)

Phosphorus is crucial and a major nutrient in the production of crops. It stimulates root formation; hastens maturity; involved in the transformation of carbohydrates involved in energy transfer related to photosynthesis and breakdown of carbohydrates; strengthen straw of grains; improves quality; and it is the constituent of the living cell. The sources of this nutrient to the soil include plant residues; various forms of manure; commercial fertilizers and other native organic and inorganic compounds.

When soils have high content of organic matter, the organic radicals block exposed hydroxyls of the sesquioxides on the surfaces of iron and aluminium oxides thereby greatly reducing phosphorus fixation capacity. Thus the top soils under this situation make more phosphorus available for plant uptake. The phosphorus data was expected to improve slightly as compared to the initial data at the onset of the project. Nonetheless, some of the data from some of the treatments and villages seems very high as compared to the initial data. This reveals that there were some problems in the analysis of the soils samples in the laboratory rendering this phosphorus data unreliable. It was expected to get the P (ppm) in the range of 1.5 to at least 3 ppm. The data is inconstant with these figures and goes as high as 37 ppm P. Efforts are to be made to trace the source of error in the determination of the phosphorus in order to give a true picture of the situation on the ground. The other way to go around this problem would be to collect fresh samples and base the conclusions on the new data. With reference to grain and stover data, it is noted that quite substantial amounts are exported from the field through the harvesting process. The proportion of P goes as high as 4% in some cases, indicating the amounts being taken away from the soils and passed on to the human bodies. These need to be recycled back into the soil.

4.2.3. Potassium (K)

This is the most abundant of all the major and secondary nutrients elements in the soil. Potassium is essential to synthesis and translocation of carbohydrates; act as a catalyst in chlorophyll formation; increases plumpness in grain formation; gives rigidity to stalk and straw of plants; necessary for tuber development; improves vigor and disease resistance; as well as imparting hardiness in legumes. The sources of this in the soil include minerals, plant residues and chemical fertilizers. Potassium is lost from the soil through cropping; leaching; and soil erosion. Normally fertile soils contain 1.0 to 2.0% total K as K_2O.

Synthesis of the soils data reveals that the soils in the area of study are moderate with regard to Potassium. The levels of Potassium tended to increase in the second year to the proportions which cannot be explain by looking at the dynamics of Potassium (Appendix 1). With the incorporation of the residues this could improve the level of Potassium in the soil based on creation of factors which accelerates weathering of soil mineral materials and solubility aspects of the different forms of Potassium in the soil. The trend of potassium increase in the soil due to incorporation of different organic materials will become apparent with time. The duration of one year is small to start seeing tangible results.

4.2.4. Calcium (Ca)

Calcium is known for its roles in the embolic control; membrane structure; cell wall structure; and its interaction with other elements, decreasing the availability of molybdenum. Calcium in acid, humid region soils occurs largely in the exchangeable form or in undecomposed primary minerals.

The results from the soils analysis in the initial and the second year show no significant difference in the levels of soil calcium. This is consistent with the thinking that a years period is not long enough to see much effects by the treatments the project is working on. This is due to the fact that some of these nutrient elements are found highly in the soil minerals and involve a lot of solution dynamics.

4.2.5. Magnesium (Mg)

Magnesium just like K and Ca is associated with enzyme activity and maintenance of the electro neutrality of the plant tissue. The roles of Mg include formation of chlorophyll; activation of enzymes; formation of cellular organelles; metabolism of carbohydrates and synthesis of proteins. Magnesium behaves more or less the same way as Ca in the soils.

The soils data indicates that there was an increase in the soil solution concentration of Mg in the second year as compared to the soils data of the first year. This is contrary to what was expected since this is not very dynamic and floats between exchangeable and/or water soluble forms. This could be deduced from the sampling techniques employed and possible contamination in the laboratory. Since this is the first year of comparison, it is advisable that care be taken in the second year of comparison in order to get a true picture by following the recommended guidelines in soil sampling following treatments.

4.2.6. Effect of Soil Organic Matter on Soil Fertility

Organic and green manures had been widely used in soil fertility programmes up to early 1960s. After that, consumption of mineral fertilisers progressively increased as traditional forms of farming had given way to more intensive systems and interest has been lost in the use of organic residues, manure and other crop residues. However, with the high price of mineral fertilisers, the situation has changed drastically, and now again more attention is given on better utilisation of organic residues in soil fertility maintenance. Besides supplying nutrient elements, organic matter has great influence on the physical, biological and chemical properties of the soil.

Organic matter influences soil structure, infiltration rate, water holding capacity, temperature regime, and resistance to soil erosion. Many soils in Malawi have low cation exchange capacity (CEC). With increased organic matter, the CEC of the soil may be increased. Over and above, in the absence of fertilisers, crops depend entirely on the mineralization of organically held nutrients for their nutrition. In view of this fact, it is important that crop residues should always be returned to the soil, either as mulch or incorporated into the soil. In general, the amount of nitrogen mineralised is proportional to the total amount present, so that the amount of nitrogen increases with organic matter content, except where the C:N ratio is high. Organic matter may also increase phosphorus availability in two ways: (a) through mineralization of organic phosphorus, which makes up an appreciable fraction of the organic matter in Malawi soils; or (b) by preventing phosphate ions ($H_2PO_4^-$) from being fixed by Al and Fe hydrous oxides, by the humus adsorption on the mineral surfaces which would otherwise adsorb phosphorus.

Mineralization of organic S appears to parallel that of N. About 80% or more of the sulphur in the savannah soils is present in the organic matter, and thus its rate of mineralization may affect crop growth.

The available data give an impression that the levels of organic matter increased substantially in the very first year. It is expected that the SOM should show positive development, but the proportion of the increment is on the higher side. Nonetheless, this indicates that the projects' venture of residue incorporation is bearing fruits. This was also alluded to during discussion with selected number of farmers who have seen some of the highlighted benefits of the SOM happening in their fields.

4.2.7. Nitrogen (N)

Nitrogen presents limitations to plant growth more than any other element. The total N content of soils ranges from 0.02% in subsoils to 2.5% in peaty soils and it is determined by a variety of factors such as climate, type of vegetation, parent material, topography, biotic activities. When virgin land is cultivated, its N content declines rapidly to equilibrium level that is characteristic of the climate, cultural practices and type of soil.

Nitrogen plays a number of important roles in the plants. These include being constituent of all living cells; encouraging vegetative growth; increasing plumpness of grain and % of protein; and also regulate the utilization of P and K. Despite nitrogen being an important nutrient chemical, oversupply has repercussions. These are delay in maturity; weakness in grain straw; and decrease in resistance to diseases.

There are a number of sources of N in the soils. The most important sources of N are the crop residues (green and animal manure); commercial fertilizers; N compounds in the air added by precipitation; fixation of atmospheric N by the symbiotic and non-symbiotic organisms of the soil. Soil organic N provides a remarkable source of N fertilizer for agricultural crops. The quantity of organic N in the soil is a function of annual losses and gains of organic N and where average annual additions equal average annual losses, it is at an equilibrium level. This level is characteristic of cultural practices and the management imposed on the system.

The data available in the second year compared with the initial year shows no significant changes. This is understood in the context that the release of N from the crop residues is slow and depends on the quality and quantity of the residues being used. The period of one year is not enough to give substantial difference. It has to be mentioned here that a comparison of treatments as regards the increase in N did not significantly differ. The reason could be that maize residues, which have a high C/N ratio, were all the time being mixed with leguminous residues. Nonetheless, note that the actual levels of N were in the range of 0.02% to 0.05% which is taken as low soil N fertility. There is need to continue with the treatments for a number of years before a clear pattern is developed on the increase on soil N due to use of crop residues. As for grain and stover data, you realize that up to 2% N a constituent of protein is passed on to humans and livestock. This gives a clear link of the flow of N from the soil to humans. Thus, there is a burning need to recycle this important nutrient by ploughing back the residues.

5.0. LITERATURE REVIEW

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Timeline of the Agriculture Cycle and Major SFHC Research & Development Activities 2000-2004

	2000-01						**2001-02: Severe Hungry Season from Dec - May**					
	June-July	**Aug-Sept**	**Oct-Nov**	**Dec-Jan**	**Feb-March**	**April-May**	**June-July**	**Aug-Sept**	**Oct-Nov**	**Dec-Jan**	**Feb-March**	**April-May**
Agriculture cycle	Harvest: Maize, soya, groundnuts	Least labour in year. Harvest ppeas (Sept)	Land prep, Early planting	Planting, Weeding Early hungry season	Hungry Season, Weeding Early maize harvest	Harvest: soya, gnuts, early maize	Harvest: Maize, soya, groundnuts	Least labour in year. Harvest ppeas	Land prep., Early planting	Planting, Weeding Early hungry season	Hungry Season, Weeding Early maize harvest	Harvest: soya, gnuts, early maize
Development Activities	Project begins. FRT selected. RBK & FRT to Mponela to learn about OMTs. OMT eval.	183 farmers get training on legumes Seed procured.	Planting of 183 farmer trials and 7 village plots. Community Trainings.	Supervision of plots.	Supervision of plots.	Field Day. Community Trainings.	IDRC contract signed OMT evaluation.	Seed procurement. Farmer training.	Planting of 456 farmer trials and 11 village plots. Community Trainings.	Supervision of plots.	Supervision of plots.	Field Day. Community Trainings.
Research activities	Qualitative research on food security, gender issues and local indicators (RBK)	Qualitative research with FRT on local indicators (RBK)	Participatory rural appraisal research done (MC)		Baseline nutrition survey (DC, MC)	.	Participatory Yield Collection (MC) Inception Workshop with IDRC.	Qualitative research on child care and feeding done (RBK, TT, MC)	Food security indicators developed (MC, TT, KN, SM) Agric BL survey. Soil sampling.	Design of Hungry Season survey (RBK, JK, MC)	Qualitative research on child feeding practices (RBK, SM, TT) Hungry Season survey.	Data entry.
Staff changes	Gaston as team leader with help from RBK & CCAP. B. Kamanga helps with field trip.	MC hired				RBK arrives	TT arrives (for 8 months). PATH Canada joins project.		KN hired as agric asst. LD hired as accountant. SM hired as nutritionist.		RBK arrives for 6 weeks to help with survey and qualitative research. TT leaves	

	2002-03						2003-04					
	June-July	**Aug-Sept**	**Oct-Nov**	**Dec-Jan**	**Feb-March**	**April-May**	**June-July**	**Aug-Sept**	**Oct-Nov**	**Dec-Jan**	**Feb-March**	**April-May**
Agriculture cycle	Harvest: Maize, soya, groundnuts	Least labour in year. Harvest ppeas (Sept)	Land prep., Early planting	Planting, Weeding Early hungry season	Hungry Season, Weeding Early maize harvest	Harvest: soya, gnuts, early maize	Harvest: Maize, soya, groundnuts	Least labour in year. Harvest ppeas	Land prep., Early planting	Planting, Weeding Early hungry season	Hungry Season, Weeding Early maize harvest	Harvest: soya, gnuts, early maize
Development Activities	OMT evaluation	Seed procurement. Farmer training.	Seed distribution for 983 farmer trials and 48 village plots. Community Trainings.	Supervision of plots.	Supervision of plots. Formation of Nutrition Team.	Field Day. Community Trainings.	Nutrition education (AS, FRT, NT) OMT evaluation.	Seed procurement. Farmer training. Nutr ed (AS, FRT, NT). Aug nutr wrkshp with DC.	Seed dist'n: 1700 farmer trials, 77 village plots (MC,LD,RBK, JS, AS) Nutr ed (AS, FRT, NT). Soya bean & gnut trials initiated. Community Trainings.	Supervision of plots. Nutr ed (AS, FRT, NT)	Supervision of plots. Nutr ed (AS, FRT, NT)	Field Day. Participatory Seed Workshop. Nutrition education (AS, FRT, NT) Community Trainings.
Research activities	Participatory Yield Collection (KN) Design of Post Harvest survey.	Post Harvest August 2002 survey	Qualitative Gender Analysis (CK, MC, LD, KN, SM) Soil sampling done.	Census done (MC, KN, LD, DR) Pre-harvest Anthropometry done (KN) Qualitative research done (MC)	Participatory Nutrition Workshop. Qualitative research on seeds (RBK, MC, KN)	Ongoing data entry & analysis.	Participatory Yield Collection (FRT) Ongoing data entry & analysis	Agronomist visit & analysis (Patson Nalivata) Ongoing data entry & analysis	Ongoing data entry & analysis	Anthropometry (KN, MC, AM) Ongoing data entry & analysis	Qualitative research on root water/child feeding. (RBK, MC, LS, LD, AS)	Qualitative research on crop residue, seed exchange (RBK, LS, MC, LD, FRT)
Staff changes	Gaston leaves; replaced by Kistone Mhango.	JK arrives to supervise survey.	SM resigns.	DR arrives as PATH intern. JK resigns, PB replaces.	RBK arrives (2 months). JS hired as temp data entry clerk.	KN resigns. DR leaves.	AS hired as community nutrition promoter	RBK arrives for diss year PB visits.	LS hired as Ass't project coordinator.			PB visits. AS and JS complete contracts.

Legend

MC	Marko Chirwa	FRT	Farmer Research Team	NT	Nutrition Team	TT	Tanya Trevors	JK	Julia Krasevec
KN	Keston Ndlovu	RBK	Rachel Bezner Kerr	DC	Dorothy Chilima	SM	Solomon Mkumbwa	LD	Laifolo Dakishoni
PB	Peter Berti	DR	David Ryan	AS	Angela Shonga	LS	Lizzie Shumba	JS	Jonah Singyangwe

Report on OMTs Experimental Plots.
6 June 2004.
SFHC Project, Ekwendeni.

SUMMARY
Trials were run in 2001-2 and 2002-3 in which the FRT's tried various legume options on experimental plots, approximately 100 m^2. In the first year of the trials (2001 and 2002) the farmers chose from a variety of legume options that were chosen for their potential to improve soil fertility. In the second year of the trials (2002 and 2003), the farmers planted maize and measured the yield. Overall, from this data, in contrast to the farmer's qualitative research, there were no differences in maize yield resulting from the previous year's treatment.

METHODS
A. 2001-2002:
- Ninety-eight farmers in seven villages, had one (n=67), two (n=23), three (n=5), four (n=1) or five (n=2) plots each, for a total of 142 plots.
- The farmers chose from six different legume options and planted them on plots of 40 m^2 (n=2), 50 m^2 (n=8), 100 m^2 (n=131), or 200 m^2 (n=1).
- Six different legume options, as well as a new, or control, options were selected as shown in the table below.
- Three different types of maize were used: masika (n=138 plots), local (n=3), MH18 (n=1).

Data were collected by the Farmer Research teams on plot size, the number of maize stalks, the weight of the stalks, the weight of the grain and the moisture content. The data can be analyzed in terms of dry or weight wet per square meter, and per stalk. However, there is little variation in moisture content by treatment, and so analyses were not done on dry weight basis.

B. 2002-2003:
- Thirty-four farmers in seven villages, had one plot each.
- The farmers chose from five different legume options; plot size data were not collected.
- Seven different legume options, were selected as shown in the table below.

Data were collected by the Farmer Research teams on the number of standing maize stalks, the number of fallend maize stalks, the weight of the stalks, and the weight of the grain. The data can be analyzed in terms of weight wet per stalk, but not per square meter, nor as dry weight, as mosture content and plot size data were not collected.

Legume Options	Number of Plots: 2001-2002	Number of Plots: 2002-2003	Number of Plots: Total
Soyabeans x pigeon peas	16	6	22
Tephrosia x maize	5	5	10
Mucuna	27	7	34
Maize x pigeon peas	26	4	30
Groundnuts	4	-	4
Groundnuts x pigeon peas	56	10	66
New	8	-	8
Macuna x maize	-	1	1
Tephrosia x pigeon peas	-	1	1
TOTAL	142	34	176

The data were analyzed in SAS using Proc GLM, testing the models:
Y = treatment village .

Where Y is kg grain per plot, kg grain per stalk, number of stalks, kg of stalks, kg per stalk, on a wet and dry weight basis. "treatment" and "village" are main effects, representing the previous season's treatment and different villages .
The 2002-3 data were included only in the kg grain per stalk wet weight analysis.

RESULTS

2001-2002 Data:

1. Number of stalks per square meter:
There were no differences between treatments, but there were differences between villages (p=.001, r^2=.23), with village averages ranging from 1.6 to 2.7 stalks per square meter. The overall average was 1.85.
2. Kg stalks per square meter:
There were no differences between treatments, but there was weak evidence of differences between villages (p=.1, r^2=.14), with village averages ranging from 0.13 to 0.22 kg stalks per square meter. The overall average was 0.17.
3. Kg grain per square meter:
There were no differences between treatments or villages (p=.2). The overall average was 0.13 kg of grain/m^2.
4. Kg grain per stalk:
There were no differences between treatments, but there were differences between villages (p=.004, r^2=.15), with village averages ranging from 0.05 to 0.11 kg grain per stalk. The overall average was 0.09.
5. Kg per stalk:
There were no differences between treatments, but there were differences between villages (p=.02, r^2=.13), with village averages ranging from 0.07 to 0.15 kg per stalk. The overall average was 0.12.

Tests were also done on comparing the productivity of the plots to the number of plots a farmer had, as a proxy measure of farmer enthusiasm for OMTs. There was no effect.

2001-2002 and 2002-2003 Data:

1. Kg grain per stalk: The only additional meaningful analysis that could be done with the merged data sets is kg of grain per stalk. There was still no treatment effect, and the village effect remained ($p=.037$, $r^2=.15$), with village averages ranging from 0.05 to 0.12 kg grain per stalk. The overall average was 0.09.

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Abstract: The Soils, Food and Healthy Communities project in Malawi takes a transdisciplinary, participatory approach to improving child nutrition with resource-poor farmers. Mixed research methods were used, including participatory rural appraisal, focus groups, unstructured interviews, questionnaires and anthropometrics. The overall research question was: can legume systems improve soil fertility, food security, child health and nutrition. Local indicators were developed in collaboration with a Farmer Research Team, themselves chosen by the involved communities. Over 2000 farmers are now experimenting with legume systems in the region. According to local indicators, pigeon pea and groundnut relay intercropped with maize results in the greatest increase in food security, while *Mucuna pruriens* rotated with maize leads to the greatest improvements in soil fertility. The Farmer Research Team was critical in mobilizing community interest in changing agricultural practices to improve child health. Innovative participatory approaches, including a farmer apprenticeship program, and improved local knowledge of linkages between soil fertility, agricultural practices, social relations and child health are some of the outcomes of the project.

Key words: legumes; food security; participatory research; soil fertility; child nutrition

Introduction

Food insecurity and malnutrition are major problems facing poor households in the Ekwendeni catchment area in northern Malawi. Studies conducted in the Ekwendeni region found that over 70% of households did not have enough food stocks to last the entire year (Young 1997; Bezner Kerr 1998). Almost half (49%) of children under five years old in Malawi were stunted in a 2001 national survey, an indication of chronic under nutrition. These statistics are almost identical to a similar survey conducted in 1991, suggesting no improvement in nutritional status for young children in the last 10 years (NSO and Macro 2001).

The problem of food insecurity and malnutrition in Malawi is intimately linked to soil fertility and land management. Most Malawian households rely on domestic agricultural production, primarily maize, to meet household food needs. Most soils in Malawi are low in nitrogen, in part due to the inherent soil characteristics of the region, very low input additions (fertilizer or organic sources) and more intensive agricultural use from an increasing population (Snapp and Blackie 2004; Snapp 1999). Most crops, particularly maize, require the addition of nitrogen for adequate growth. Low input use is common throughout Sub-Saharan Africa, estimated at 10 kg/ha, and lower in poor countries such as Malawi (Snapp and Blackie 2004). Fertilizer use in Malawi has remained at low levels for over a decade, due to the rising cost of living and removal of fertilizer subsidies; one study found that approximately 30% of households apply fertilizer to crops, at 40 kg/ha, far below the recommended rates (Snapp et al. 2002a).

A variety of ‘legume options’ such as intercropping nitrogen-fixing plants (grain or perennial legumes) with maize are promising nitrogen-input alternatives for resource-poor farmers in Malawi (Snapp et al. 1998; Kamanga *et al.* 2001). In addition, grain legumes provide a nutritious alternative food source, as they are higher in protein and some micronutrients than maize (Salunkhe et al. 1986). The Soils, Food and Healthy Communities (SFHC) project, based at Ekwendeni Hospital in northern Malawi tests the hypothesis that different legume options could improve soil fertility, food security, health and nutrition of resource-poor households, particularly under-five children. The legume options selected by farmers in the SFHC project were previously tested on-farm for soil fertility enhancement in Central Malawi, primarily using researcher-led trials (Snapp *et al.* 2002a; Snapp and Blackie 2003). The SFHC project employed a farmer participatory research framework to test the efficacy of the legume options for resource-poor farmers. Whether these legumes can help improve food security or child nutrition has not been previously tested. The legume options are: 1) maize (*Zea mays*) intercropped with pigeon pea (*Cajanus cajun*); 2) pigeon pea intercropped with soybean, then rotated with maize; 3) pigeon pea intercropped with groundnut then rotated with maize; 4) *Mucuna pruriens* rotated with maize 5) *Tephrosia vogelii* intercropped with maize. Crop residue must be buried soon after harvest for all five options, in order to provide adequate nitrogen and organic matter for the maize crop the following agricultural season.

Fieldwork Setting

Malawi is a highly rural country, with approximately 80% living in villages with less than 1000 people (NSO 2002). The research reported here was conducted in a rural area of northern Malawi, 15-20 kilometres north-east of Ekwendeni, a town of approximately 10,000 people, and 50 kilometres north of Mzuzu, a city of about 60,000 people. Ekwendeni is located in the mid-altitude hillside region of Malawi, on the western side of the Rift Valley, at approximately 1200 m.s.l. (Benson 2002). The rainy season is from November to April. In the study region, the vast majority of household rely on their own agricultural production for food supplies, although they also have other livelihood activities, such as small businesses, labour on other people's farms, and cash crop cultivation (Bezner Kerr 2003a). Households grow maize during the rainy season as the staple crop, in addition to beans, squash, groundnuts, millet, sweet potatoes and other crops. Tobacco is an increasingly common cash crop grown throughout the region during the rainy season. During the dry season many households have a vegetable garden to cultivate crops such as green leafy vegetables, tomatoes or sweet peas. *Dambo* gardens are constructed on fertile riverbank soil, and provide food during the hungry months. Dry season gardens, or *dimbas*, are cultivated on poorer soils and required watering by hand.

Seven villages were initially selected for the research project, five of which were known to have higher than Ekwendeni-average levels of child stunting, and two that had a higher level of anaemia. The village sampling technique was purposeful sampling (Patton 1996), as these two village areas represent characteristics of particular health problems (malnutrition and anaemia) related to the broader phenomenon of food security. Two of the villages are located near a major highway, with the remaining five villages set further away from major transport routes. One village has a grain mill, school and mobile health clinic. One village had several large tobacco estates located in the nearby vicinity. Comparison interviews were also carried out in villages where the project did not operate to ensure that responses from subject villages were not confounded by involvement in the research program. These villages were all within the Ekwendeni catchment area. This study is thus not representative of Malawi, or even Northern Malawi, but rather is an intensive case study that attempts to understand the linkages between soil fertility, food security and child health and nutrition.

Research Approach and Methods

A participatory agroecosystem approach was explicitly taken in this project. The complex inter-related nature of food security, soil fertility, health, nutrition and social relationships is recognized. The research team took a multi-faceted, transdisciplinary approach to address these problems. The research team is made up of a nutritionist, sociologist, agronomist, community development specialist and community members. At the heart of the approach is a community-based method, which relies heavily on input from the Farmer Research Team and Village Committees. Collaborative problem solving and critical reflection was carried out with poor households to develop appropriate agricultural technology for their needs, build the confidence of local farmers to carry out research, and respect their perspective (Selener 1997; Meulenberg-Buskens 1996; Hagmann et al 1997). The assumption is that resource-poor farmers have valuable knowledge to contribute to the assessment of organic matter technologies for improving food security and health (Selener 1997; Hagmann et al 1997). The different needs and priorities of various groups in a community, however, are also recognized (Guijt and Shah 1999). Community-based indicators of health, food security and soil fertility were identified, in order to evaluate and monitor the trials from different local as well as outside perspectives (Lee-Smith 1997).

Farmer participatory research has been tested in many parts of the world, and is now recognized as an important way to develop and improve agricultural technologies as well as disseminate knowledge in a meaningful way (Ashby et al 1997; Hagmann et al 1997; Gubbels 1997). The use of a ‘farmer research team’ replicates other participatory efforts in Africa and Central America, where small farmer groups carry out research for the broader community (Ishag et al 1997; Humphries et al 1999; Ashby et al 1997). Other records of farmer participatory research have noted that village-level research teams are often made up of the better-off, male members of the community and at times the tested technologies are not spread far beyond the research teams (Humphries et al 1999; Guijt and Shah 1999). In order to make the selection process as participatory as possible within the constraints imposed by differing access to wealth and power, the PHC team asked the villagers to select a ‘representative’ group of people. For example communities could select some women, some men, some married people, some non-married, some poor, some better off, some food insecure and some food secure members.

The FRT first visited farmers in central Malawi and were trained by a Malawian agronomist about the different legume options. The FRT then took the information back to the villagers, and suggested anyone in the village could do on-farm trials with the 5 different legume options. This approach attempted to spread the knowledge well beyond the original FRT, thereby addressing the other issue faced by farmer participatory research models. Using the ‘mother-baby’ trial model first tested in Malawi (Snapp et al.

2002b), the FRT tested all 5 legume options in a village plot, while an individual farmer tested only the legume options of interest to her in 10 x 10 m plots for each legume option.

Activities of the Farmer Research Team

The FRT visited farmers to provide agronomic advice and to carry out participatory research on the trials. SFHC staff provided training to the FRT in group dynamics, leadership, participatory approaches, agronomic and health information. The second year of the project, the number of participating farmers more than doubled, most of the additions were women from female-headed households. The Farmer Research Team was unable to supervise all the participating farmers, and decided to ask for additional help from the villagers. Village Committees were formed to assist with the work of the Farmer Research Team, resolve community conflicts related to the project and to report back to the communities. The committees were elected by villagers themselves. Most of the members selected were from female headed households, with 70% of the village committee members being women. The Farmer Research Team, Village Committees and SFHC research team investigate legume systems using local and scientific indicators.

Thus far the project has found that Farmer Research Teams are effective means to promote and test agricultural innovations. From a community development perspective, the project has been highly successful in disseminating knowledge about legumes as a source of soil fertility, food security and child health. The first year of the project there were 183 participating farmers from 7 villages. The following year, 456 participants came from 11 villages. In the third year there were 1,800 farmers from 18 villages, and in

2003-04 (the fourth research season), almost 3,000 farmers from 77 villages participated in the project.

Many farmers have expanded the use of legumes well beyond the initial small on-farm trials. They have experimented with different ways to apply legume options, including growing pigeon pea for two years instead of one, and burying crop residue at different time periods.

Methods

Multiple methods, including anthropometry, dietary data, focus group discussions, participatory rural appraisal and structured questionnaires were utilized by the research team. This paper will focus on the participatory and qualitative research carried out in conjunction with the Farmer Research Team.

Participatory rural appraisal methods (i.e. seasonal calendars, village mapping and food security ranking) were undertaken to understand current agricultural practices, perceptions of soil fertility, inter and intra household division of labor, constraints to food security, local indicators for food security and perceptions of child health and nutrition (Slocum et al. 1996). Semi-structured interviews on agricultural practices, intra and inter household division of labor and perceptions of soil fertility were conducted with 30 farmers by the sociological researcher (Bezner Kerr 2003b). A food security ranking exercise was carried out to understand local indicators of food security, and to incorporate these indicators into the research methods and analysis.

The FRT collected yield data from all intervention households at harvest each year. Annual participatory evaluations of the legume systems were carried out by SFHC staff and the FRT, using pairwise ranking and small group discussions (Slocum *et al.* 1996). Initial analysis of the first two phases of the research led to follow-up participatory and qualitative research. Gender and household issues identified during the first phase of the project led to additional focus groups and semi-structured interviews.

Results and Discussion

This paper will report on the results from some of the participatory and qualitative research carried out with participating farmers. There are two main areas of findings reported here: 1) community assessment of legumes; 2) innovative participatory research approaches and key community dynamics.

Community Assessment of Legumes

Local indicators were developed by participating farmers in consultation with the SFHC research team to assess the legume options from a community perspective (Table 1). Measurement of soil fertility and food security was the easiest assessment for villagers, while assessment of health and gender relations was more difficult. Discussions about gender relations indicated a fair amount of resistance to modification of traditional gender relations, particularly from men and older women.

(Table 1 here)

Once the indicators were developed, each village developed an action plan, and all 1,800 participating farmers were visited to assess the legume options using the local indicators. The Farmer Research Team and SFHC staff met one month later to discuss the results. The strengths and weaknesses of each of the technologies were assessed (Table 2).

(Table 2 here)

Farmers rated the legume system of intercropped pigeon pea and groundnut rotated with maize as the most effective at improving food security. Pigeon pea provides a legume late in the harvest period, at a time when there are limited supplies of other quality foods available. Groundnuts are utilized in numerous local dishes and the higher yielding improved variety (CG7) used in the trials provided a considerable contribution to family meals. In terms of improving soil fertility, mucuna was considered the most effective. Farmers noted, however, that since mucuna could only be eaten if it was cooked for more than 6 hours, it tended to have limited use as a food source. Farmers growing mucuna have found an improvement in soil fertility based on local indicators such as maize growth and soil color. Farmers with more land available are more likely to use mucuna, since they can afford to set aside land solely for soil fertility improvement for one year.

Focus groups and interviews with men and women about intra household decision-making revealed several important issues. Wives who participated in the project without approval of their husbands experienced problems with jealousy and lack of agricultural labor from their husbands. Men often sold the legume crops and used the money for non-household benefit, particularly alcohol. Since women often carried out the agricultural labor required for the legume crop, they found the additional legume crop at times more of a burden than a household benefit. Although in the past legumes were considered to be more of a female responsibility, those legumes that could be sold, particularly groundnuts, became more of a ‘male’ responsibility, since control of cash is largely dominated by men. Interestingly, soybean and pigeon pea seem less likely to be sold as a cash crop, and more closely linked to child nutrition by villagers. Extensive regional hospital extension programs which promote soybean as a nutritious food for children, especially when combined with maize flour to make porridge, appear to have been quite effective.

Labor shortages within the household had multiple links to agriculture and food security. Health problems within the extended family could lead to the loss of a seed variety for many years, because women had to attend to the sick person. Food insecurity could force families to consume their planting seed. Food insecure families relied on day labor jobs (ganyu) as a source of seeds and food; but the ganyu work also conflicted with their own production (Bezner Kerr 2003b).

Issues of the Farmer Research Team Approach

There have been many setbacks and challenges for the Farmer Research Team during the project. Accusations of witchcraft and adultery towards FRT members who visited participating farmers were common in the first year of the project; this problem has reduced as the project became widely known. Another issue has been the ongoing challenge for the volunteers to visit all participating farmers in the project. The purchase of bicycles in 2002 was meant to assist them in this endeavor, but it led to additional disputes, discussed below.

A participatory evaluation by the Farmer Research Team of farmers' fields in 2003 suggests that many farmers are not incorporating crop residue in a timely way, which limits the enhancement of soil fertility. The agronomist's assessment of fields later in the year supported this finding. Discussions with members of the Farmer Research Team and Village Committees indicated that a dispute over authority and power was at the heart of the problem. The Farmer Research Team and the Village Committees were in conflict over who was in charge, and who was responsible for what activities in the project. This conflict was particularly evident when bicycles were distributed to villages for the Farmer Research Team and Village Committees to use to visit participating farmers. Both groups felt that they were the primary owners of the bicycles, and the conflict led to reduced participation in the project, particularly in terms of farming the village plots. SFHC staff held several meetings about the project and discovered that both the FRT and the Village Committees were discouraged, despite the apparent success of the project. As the project has expanded the requirements for these volunteers has also expanded, with limited benefits for their efforts. In 2003 the SFHC staff began to address this issue, by working to acknowledge and support the Farmer Research Team and Village Committees more effectively. One way they are doing so is through a 'Farmer Apprenticeship' program. Each new village that joins has to elect members of the Farmer Research Team (2 members, one man and one woman) who are also members of the Village Committee. The new Farmer Research Team members will spend one day working in the field of an old Farmer Research Team member who is known for his or her excellent farming practices. New FRT members will learn about their agricultural practices by working side by side in their fields. This approach will provide one day of free agricultural labor for the old FRT members, will provide them the prestige of a visit from someone in another village, and will be an innovative teaching method for the new FRT member. In addition, in new project villages the FRT and Village Committee memberships have been merged to avoid disputes over authority.

Another interesting ‘finding’ was the high time burden of quantitative research on community members. SFHC staff, FRT members, village leaders and community members expressed frustration at the high time commitment, needed resources and lack of quick feedback from intensive quantitative survey methods. Community members often felt neglected by project staff and could not address important community conflicts due to the time burden of participating in quantitative research. ‘Control’ villages in surveys felt little incentive to participate in the research. Focus group discussions, semi-structured interviews and Participatory Rural Appraisal methods such as seasonal calendars proved more effective at sharing knowledge.

Conclusion

The legume system ranked the highest for food security by farmers, pigeon pea and groundnut, was not as effective at improving soil fertility. Mucuna was ranked as the best legume system for soil fertility improvement, but did not add any edible legume to the household diet. Women preferred pigeon pea and soybean as a means to improve child nutrition. There were many factors, however, that prevented households from using the legumes to improve child nutrition. Seed loss could occur due to health problems within the extended family. Many families ate their planting seed due to food shortages. During the hungry season food insecure families relied on day labor as a source of seeds and food; but the work also conflicted with their own food production, thus reducing yields.

At a research project level, the Farmer Research Team proved to be successful in disseminating knowledge about improvement of soil fertility, food security and health. Villagers were enthusiastic and willing to commit to long hours in order to try to solve problems of food insecurity and child malnutrition in their communities. The critical involvement of community members was a heavy time commitment for them, and adequate recognition of their contribution needed to be built into the project. Qualitative methods appeared to be more amenable to a community-based project.

Agricultural production alone, however, will not improve child nutrition, unless issues such as the household division of labor and control of resources are addressed (Bezner Kerr 2003a; Berti, Krasevec and FitzGerald, 2004). Wives who used legumes from the project without approval of their husband had problems with jealousy and lack of agricultural labor from the husband. Some wives indicated that their husbands sold the legumes and used the funds for purposes that did not improve child health and nutrition. The next steps for the research team involve: 1) making the leap from improved soil fertility and food security to improved child nutrition and health; 2) addressing the labor needs of vulnerable households, such as the AIDS-affected and food insecure families; and 3) ensuring the sustainability of all aspects of the project as it expands, including the Farmer Research Team, seed availability and nutrition education.

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Figure 1: Map of Malawi, including location of research site

(Adapted from two maps, at http://www.worldrover.com/vital/malawi.html and FAO 1997 map indicating provincial boundaries)

Table 1: Local Indicators for Food Security, Soil Fertility, Health & Gender Relations

Indicator	Soil Fertility	Food Security	Health	Gender Relations
1	Soil is dark colored like manure.	Full granaries.	Family members are usually not ill.	Child care and feeding done by both parents.
2	Vigorous growth of crops.	Amount of yield at harvest.	Family eats many different types of food.	Household responsibilities shared.
3	Soil forms 'clumps'.	Time that the maize stocks run out.	Children are strong and playful.	Decisions made by both men and women.
4	Vigorous growth of weeds.	Having three meals a day.	The agricultural labor on the farm is done on time.	
5	Availability of worms or other soil biota.	Amount of time you have to do labor for food (*ganyu*)	Children are able to complete their education.	
6		Number of livestock		
7		Happy family		
8		Frequent visitors		
9		Family has money.		
10		Children grow well.		

Table 2: Farmer Assessment of Legume Options in terms of Soil Fertility, Food Security, Child Health and Nutrition and Social Issues

Legume Option	Soil Fertility	Food Security	Child Health and Nutrition	Social Issues
Groundnut and Pigeon pea intercropped, maize grown following year.	Limited improvement of soil fertility. Pest problems (*i.e.* beetles) limit yields and biomass. More effective if p/pea grown as improved fallow for second year.	Good food source. High yields of g/nuts, which can be used in many recipes. P/pea available late in the dry season when other food not available. P/pea source of firewood.	Groundnuts and pigeon pea can be used in a porridge for young children. P/peas are a source for medicine for earaches and diarrhea.	Two crops produced on one field which reduces labor. Source of cash, however men tend to sell groundnuts and use cash for non-household use. Both crops good sources of gifts and bartering. P/pea remains in field and is eaten by livestock.
Soybean and Pigeon pea intercropped, maize grown next year.	Limited improvement of soil fertility. Pest problems limit yields. Soybean variety used grows poorly and produces very little biomass. More effective if p/pea grown as improved fallow for second year.	Good food source. Soybeans used in many recipes. P/pea available late in the dry season when other food not available. P/pea source of firewood.	Soybeans considered very nutritious for young children. P/peas are a source for medicine for earaches and diarrhea.	Both crops are good sources of gifts and for bartering. Two crops produced on one field which reduces labor. P/pea remains in field and is eaten by livestock.
Maize and pigeon pea intercropped, rotated with maize the following year.	Very low soil fertility improvement. Pest problems (*i.e.* beetles) limit yields and biomass. More effective if p/pea grown as improved fallow for second year.	Good food source, and get primary food crop from field (maize). P/pea available late in the dry season when other food not available. P/pea source of firewood.	P/pea can be used in a porridge for young children. P/peas are a source for medicine for earaches and diarrhea.	Two crops produced on one field which reduces labor. P/pea is a good source of gifts and for bartering. P/pea remains in field and is eaten by livestock.
Tephrosia voglii intercropped with maize, rotated with maize the following year.	Good soil fertility improvement.	Get primary food crop from field (maize), but limited yield of one crop. Tephrosia leaves can be used as an insecticide in vegetable gardens, and can be used to treat seed and protect from weevils. Tephrosia is a source of firewood.	Limited direct effect on child health and nutrition, although use of tephrosia as an insecticide in vegetable gardens may increase vegetable sources for young children.	Considered a 'tree' so it is controlled by men, who control the land.
Mucuna spp. Rotated with maize	Best soil fertility improvement. Improves soil moisture retention. Improves soil structure.	Cannot eat crop without cooking it for a long time. Vigorous growth means cannot be grown with other crops.	No clear link with child nutrition, although increases maize growth the following year.	Smothers weeds so reduces labor. No market for the crop. Need to bury crop residue at labor peak, and high biomass production means burial is hard work.

Article for Soil Fertility Network
Rachel Bezner Kerr, Marko Chirwa and Keston Ndhlovu
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Health, nutrition and soil fertility are three issues in Malawi that are inextricably linked, but rarely examined together. A primary health care department in northern Malawi is carrying out a program that will try to use agricultural practices combined with community nutrition education to improve children's health and nutrition. The idea for the Soils, Food and Healthy Communities (SFHC) project was born out of the high levels of malnourished children that the staff of the Primary Health Care department of Ekwendeni Hospital saw in their catchment area of Ekwendeni, in northern Malawi. Although they were trying to address the issue of malnutrition through programs such as a mobile clinic, a malaria control program and community grain banks, they felt that they needed to look at the issue from an agricultural perspective. They conducted interviews on food security in 1997 in conjunction with Rachel Bezner Kerr, who was then doing her M.Sc. in land resource science at the University of Guelph, in Canada. Low soil fertility and a lack of funds to buy fertilizer was the most common issue cited by the informants. Based on the findings, the Primary Health Care staff decided to start a pilot project with alternatives to fertilizer. In consultations with local communities they identified 7 villages where the pilot project would be conducted. The basic idea of the project is that farmers test different legumes as alternative sources to fertilizer, to see if these organic matter technologies lead to improvements in soil fertility, food security, health and nutrition at the household level, particularly for children under five years old.

A somewhat unique participatory approach is being used by the project, by combining the CIAL approach spearheaded by CIAT with a wider community-based experimentation approach that other organizations have advocated. The villagers first selected four representatives from each village who make up the Farmer Research Team. Although the SFHC staff did not set limits on the selection process, they did ask that the farmers selected be representative of various groups in the village: men, women, poor, food insecure, wealthy, female-headed etc. Interviews conducted the first year of the project indicated that the FRT were from a wide cross section of the communities. These 30 farmers then went on a farmer exchange in 2000, to learn what other farmers have tested in Central Malawi, visiting projects run by CIMMYT, ICRISAT and the Ministry of Agriculture. Upon their return to Ekwendeni, the FRT presented their findings to their villages. Anyone in the village could then sign up to test the different organic matter technologies in a small portion of their land.

After consultations with numerous organizations, including ICRISAT, CIMMYT, ICRAF, MAFE and the Ministry of Agriculture, the SFHC team decided on five different options offered to farmers to test:

1) pigeon pea and maize intercropped
2) pigeon pea and groundnut intercropped and rotated with maize
3) pigeon pea and soya bean intercropped and rotated with maize
4) mucuna grown as a sole crop, rotated with maize

5) *Tephrosia voglii* relay intercropped with maize, grown as a sole crop the second year, then rotated with maize

A farmer can select up to 2 options to test in small plots on her own fields, and each village also has a community plot which tests all 5 options. This model is known as 'mother-baby trials' and has been used successfully in other parts of Malawi. The Farmer Research Team acts as a link between the SFHC staff and the villagers, by providing advice and problem-solving with farmers. A village committee oversees the work of the farmer research team. The first year over 180 farmers carried out trials on their fields. Families liked the options that provided edible legumes to the household, in addition to improving the soil nitrogen levels. The legumes have provided a source of food as well as cash to many food-insecure families in the region, and many families have suggested that this difference has been important during the hungry season. After the first agricultural season, 2000-2001, the results appeared so promising that another 250 farmers signed up to carry out trials on their farms. Participatory monitoring methods are being used to evaluate the different options at each harvest period, as well as ongoing problem-solving throughout the cultivation period.

The SFHC team, however, are going to go beyond simply carrying out on-farm trials with these organic matter technologies. They want to see changes in young children's nutrition at the household level. An improvement in soil fertility and an increase in crop diversity alone will not necessarily lead to improvements in child nutrition. Thus, they are initiating a community nutrition education program, that will include consultations with the community elders who are extremely influential in child care and feeding practices. This community nutrition program is being designed after qualitative and quantitative research conducted in the villages, and will start in 2003. Throughout the entire project, SFHC is carrying out research in collaboration with PATH-Canada and a doctoral student at Cornell University (Rachel Bezner Kerr) to examine whether these agricultural technologies lead to changes in soil fertility, food security, health and nutrition in the communities. Local indicators for all of these variables are also being measured, to see if the project improves the lives of villagers by local criteria. Dr. Webster Sakala of Chitedze Research Station, Dr. Dorothy Chilima of Bunda College of Agriculture, University of Malawi, and Dr. Wiseman Chirwa of the Center for Social Research, University of Malawi are collaborating researchers with the project. Additional assistance has come from the Malawi Agroforestry Extension program (MAFE) and…

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FARMER EVALUATION REPORT

Farmer evaluation for organic matter technologies meeting were held on 16th and 29th April. The meeting brought all members of Farmer Research Team and all members of Village Committees who represented the entire participating members. 87 members attended on day one and 94 members attended on day two.

On day one(16th April) the participants re-visited the local indicators developed and came up with the following indicators:

1. **Soil Fertility Indicators**
   - Vigorous growth of the weed.
   - Presence of worms in the soil
   - Presence of moth
   - Soil colour changes to black
   - Plants growth and production
   - Friable soil
   - Large proportion of organic matter
   -

2. **Food Security Indicators**
   - The granary is full
   - Good crop stand and its good management
   - The crop diversification approach
   - Livestock diversification
   - Have food through out the year
   - Have more visitors
   - Have also cash
   - Other activities are carried out very well.
   - Becomes the source of food for the community be it for labour exchange or market.
   - The family does not keep on begging.
   - Have surplus food from their requirement

3. **Health Indicators**
   - Has good house that does not leak when it is raining
   - House members have healthy bodies
   - The children are not malnourished
   - Leads a happy family
   - Does not frequently get sick
   - Dress well
   - Has good pit latrine
   - Good bath room
   - Has good kitchen
   - Has a dust bin/rubbish pit
   - Receives visitors very well

- Have intelligent children

After farmers revisited these indicators did plenary and each village made an action plan to go home and visit all 2000 farmers fields. This was to evaluate each technology separately in regards to the strengths and weaknesses. After two weeks farmers gathered again to present their findings of the strengths and weaknesses of each intervention. Below are their presentations:

1. INTERCROPPING GROUNDNUTS AND PIGEON PEAS

(a) STRENGTHS

- Improves soil fertility
- Groundnuts and pigeon peas forms source of relish
- Source of cash after selling either maize or pigeon peas
- Sources of gifts to friends
- Bartering item with other needed items
- Two crops are produced on the same piece of land and serves labour.
- P/peas source of firewood
- P/peas is a source for medicine for an ear

(b) WEAKNESS

- Pigeon peas susceptible to pests and diseases
- Groundnuts susceptibility to diseases and pests
- P/peas remains in field and favored by livestock
- P/peas is late maturing

2. INTERCROPPING SOYABEANS AND PIGEON PEAS

(a) STRENGTHS

- Improves the soil fertility
- Soyabeans provides nutritive flour for porridge, for baking chikondamoyo (cake), source of milk, mix with relish.
- Pigeon peas is source of relish
- Source of cash after selling either maize or pigeon peas
- Sources of gifts to friends
- Bartering item with other needed items
- Two crops are produced on the same piece of land and serves labour.
- P/peas source of firewood
- P/peas is a source for medicine for an ear

(b) WEAKNESS

- Pigeon peas susceptible to pests and diseases, such as termites and fussarium wilt resp.
- Soyabeans difficult to establish once birds have realized that you have just planted. Birds come and pick.
- P/peas remains in field and favored by livestock
- P/peas is late maturing
-

3. INTERCROPPING MAIZE AND PIGEON PEAS

(a) STRENGTHS

- Improves soil fertility
- Maize is source of nsima
- Pigeon peas is source of relish
- Source of cash after selling either maize or pigeon peas
- Sources of gifts to friends
- Bartering item with other needed items
- Two crops are produced on the same piece of land and serves labour.
- P/peas source of firewood
- P/peas is a source for medicine for an ear

(b) WEAKNESS

- Low rate of soil improvement
- P/peas remains in field and favored by livestock
- P/peas is late maturing

4. INTERCROPPING MAIZE AND TEPHROSIA

(a) STRENGTHS

- Improves soil fertility
- Maize is source of nsima
- Tephrosia is a good pesticides that even kills among other termites
- Plant two crops at the same piece of land
- Seed can be reserved
- Source of firewood
- Is a good seed dresser (as actellic)

(b) WEAKNESS

- Tephrosia can not be consumed
- Is poisonous to other animal spices such as fish
- Maize is susceptible to monkeys

5. **ROTATING MUCUNA AND MAIZE**

(a) **STRENGTHS**

- Improves soil fertility much more than other treatments
- Smoothers weeds
- Improves soil moisture retain ion
- Improves soil structure
- Germination and establishment is always excellent

(b) **WEAKNESS**

- Has no market so far
- So far can not be eaten
- Its poisonous if you cook without proper training
- Is planted as a sole crop because of its plant habit (creeping)
- In the first year there is no benefit
- Burying of mucuna is at labour peak and tedious

After village presentations, interventions and crops were ranked according to priority using the pair wise method as follows:

1. **PAIRWISE RANKING FOR INTERVENTIONS FOR SOIL FERTILITY IMPROVEMENT**

	Rotating Mucuna and maize	**Inter. G/nuts & P/peas**	**Inter. Soybeans &P/peas**	**Inter. Maize & Tephrosia**	**Inter. Maize & P/peas**	**TOTAL SCORES**	**RANK**
Rotating Mucuna and maize	X	Rotating Mucuna and maize	Rotating Mucuna and maize	Rotating Mucuna and maize	Rotating Mucuna and maize	4	1
Inter. G/nuts & P/peas	X	X	Inter. G/nuts & P/peas	Inter. G/nuts & P/peas	Inter. G/nuts & P/peas	3	2
Inter. Soybeans &P/peas	X	X	X	Inter. Soybeans &P/peas	Inter. Soybeans &P/peas	2	3
Inter. Maize & Tephrosia	X	X	X	X	Inter. Maize & Tephrosia	1	4
Inter. Maize & P/peas	X	X	X	X	X	0	5

2. PAIRWISE RANKING FOR THE CROPS USED IN INTERVENTIONS FOR THEIR USE MOSTLY AS FOOD

	Groundnuts	Maize	Pigeon peas	Mucuna	Soybeans	Tephrosia	TOTAL SCORES	RANK
Groundnuts	X	**Maize**	**Groundnuts**	**Groundnuts**	**Groundnuts**	**Groundnuts**	4	2
Maize	X	X	**Maize**	**Maize**	**Maize**	**Maize**	5	1
Pigeon peas	X	X	X	**Pigeon peas**	**Soybeans**	**Pigeon peas**	2	4
Mucuna	X	X	X	X	**Soybeans**	**Mucuna**	1	5
Soybeans	X	X	X	X	X	**Soybeans**	3	3
Tephrosia	X	X	X	X	X	X	0	6