African Studies Quarterly

Volume 6, Issues 1 & 2
Spring 2002

Special Issue

Gender and Soil Fertility in Africa

Guest Editors: Christina H. Gladwin, Lin Cassidy, Parakh N. Hoon

Published by the Center for African Studies, University of Florida

ISSN: 2152-2448

African Studies Quarterly

Table of Contents

Introduction to Gender and Soil Fertility in Africa
Christina H. Gladwin (1-26)

Gendered Evidence of the Decline of Soil Fertility and Agricultural Productivity in Africa

Gender and Soil Fertility in Uganda: A Comparison of Soil Fertility Indicators on Women's and Men's Agricultural Plots
Peter Nkedi-Kizza, Jacob Aniku, Kafui Awuma, and Christina H. Gladwin (27-43)

Gender and Soil Fertility Management in Mbale District, Southeastern Uganda
Abe Goldman and Kathleen Heldenbrand (45-76)

Diminishing choices: Gender and Household Food Security Decisions in Malawi
Robert Uttaro (77-110)

Gendered Scripts and Declining Soil fertility in Southern Ethiopia
Michael Dougherty (111-156)

Testing A Diversity of Solutions for a Diversity of Farmers

Gender, Household Composition, and Adoption of Soil Fertility Technologies: A Study of Women Rice Farmers in Southern Senegal
Amy J. Sullivan (157-173)

The Effect of Cash Cropping, Credit, and Household Composition on Food Security in Southern Malawi
Andrea S. Anderson (175-202)

Vouchers versus Grants: Evidence from Malawi's Starter Pack Program
Amy E. Gough, Peter E. Hildebrand, and Christina H. Gladwin (203-222)

Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi
Robert A. Gilbert, Webster D. Sakala, and Todd D. Benson (223-243)

Agroforestry Innovations in Africa: Can they Improve Soil Fertility on Women Farmers' Fields?
Christina H. Gladwin, Jennifer S. Peterson, and Robert Uttaro (245-269)

Modeling Agroforestry Adoption and Household Decision Making in Malawi
Paul H. Thangata, Peter E. Hildebrand, and Christina H. Gladwin (271-293)

Gender-sensitive LP Models in Soil Fertility Research for Smallholder Farmers: Reaching de jure Female Headed Households in Zimbabwe
Maxwell Mudhara, Peter E. Hildebrand, and Christina H. Gladwin (295-309)

Conclusion and Implications for Policy

Is Fertilizer a Public or Private Good in Africa? An Opinion Piece
Christina Gladwin, Alan Randall, Andrew Schmidt, and G. Edward Schuh (311-321)

Book Reviews

Shady Practices: Agroforestry and Gender Politics in The Gambia.
Richard A. Schroeder. Berkeley: University of California Press, 1999. Pp. 172.
James T. Murphy (323-325)

Ethiopia: A Post-Cold War African State.
Theodore M. Vestal. Westport, CT: Praeger, 1999. Pp. 229.

Ethiopia: A New Start?
Kjetil Tronvoll. UK: Minority Rights Group International, 2000. Pp. 36.
Olufemi A. Akinola (326-330)

State Legitimacy and Development in Africa. .
Pierre Englebert. Boulder: Lynne Reinner, 2000. Pp. 244.
Brendan McSherry (330-332)

Do I Still Have a Life? Voices from the Aftermath of War in Rwanda and Burundi.
John M. Janzen & Reinhild Kauenhoven Janzen. Lawrence: University of Kansas, 2000. Pp. 234.
Saskia Van Hoyweghen (332-334)

State, Civil Society and Apartheid: An Examination of Dutch Reformed Church-State Relations.
Tracy Kuperus. New York: St. Martin's Press, 1999. Pp. 211.
Lyn Graybill (334-335)

Textual Politics from Slavery to Postcolonialism: Race and Identification.
Carl Plasa. New York: St. Martin's Press, 2000. Pp. 172.
Samantha Manchester Earley (335-337)

Gender and Soil Fertility in Africa: Introduction

CHRISTINA H. GLADWIN

Abstract: Soil fertility is the number-one natural resource in Africa; yet its depletion on smallholder farms has led to stagnant or decreasing per capita food production all over Africa during the last two decades. Unexamined – except in this special edition – are the gender impacts of the soil fertility crisis in Africa. The papers in this issue, the result of a University of Florida project called "Gender and Soil Fertility in Africa," assume — if one generalization can be made about the diverse farming systems and multitude of cultural traditions in sub-Saharan Africa – that women farmers usually produce the subsistence food crops, while men produce export and cash crops. African women on small rainfed farms produce up to 70-80% of the domestic food supply in most sub-Saharan African societies and also provide 46% of the agricultural labor. However, women's food-crop yields are generally low -- too low by Green Revolution standards, and much lower than men's yields. The papers collected here examine different projects in Africa with respect to the different methods used to reach women farmers in order to improve their soils and increase their yields. Such methods include fertilizer vouchers and grants, microcredit, small bags of fertilizer, agroforestry and legume innovations, and increased cash cropping by women. Results demonstrate to African policy makers which methods work, and reach women farmers with different household compositions, so that they can reverse the alarming trend toward declining per capita food production.

Introduction

Papers in this special edition, the result of a University of Florida project called "Gender and Soil Fertility in Africa," assume that-- if one generalization can be made about the diverse farming systems and multitude of cultural traditions in sub-Saharan Africa, women farmers usually produce the subsistence food crops, while men produce export and cash crops. [1] African women on small rainfed farms produce up to 70-80% of the domestic food supply in

Christina H. Gladwin is professor, Food and Resource Economics, Box 110240 IFAS, University of Florida, Gainesville, FL 32611. She has been the principal investigator of the UF Soils CRSP (collaborative research support project) "Gender and Soil Fertility in Africa" from 1997 to 2002. She is very grateful for support from: women and men farmers who repeatedly welcomed us into their homes and fields; colleagues like Clif Hiebsch, Max Langham, Pete Hildebrand, and Ken Buhr who brainstormed the objectives of this project; others who authored excellent papers in this special edition and put in endless hours on the project; Charles Sloger who managed the Soils CRSP in USAID and provided many insightful comments about the project's direction and goals; Lin Cassidy who endlessly reviewed and edited the papers; reviewers who provided timely anonymous reviews; Betty Finn, Lisette Stall, and Charity Blomely of IFAS International Programs who managed the accounting and travel; Parakh Hoon and other editors of the African Studies Quaterly and Dr. Michael Chege, past director of the UF Center for African Studies, who worked tirelessly to get out this special edition of the ASQ, and funds graciously provided from USAID through the Soils Management CRSP and World Vision International. All errors and omissions are her responsibility.

http://www.africa.ufl.edu/asq/v6/v6i1-2a1.pdf

ISSN: 2152-2448

most sub-Saharan African societies. On average, they also provide 46% of the agricultural labor. [2] However, women's yields are too low by Green Revolution standards (three to four tons per hectare for food grains), and much lower than men's yields in societies where a comparison can be made (e.g., where men grow the same crops on different fields or yields of female headed households can be compared to those of male headed households. [3] In these situations, gender differences in productivity have been shown to be due to differences in the *intensity of use* of productive inputs (such as fertilizer, manure, land and labor, credit, extension training, and education) rather than in differences in the efficiency or management styles of men and women. [4] Because women farmers lack access to cash and/or credit to acquire modern yield-increasing inputs of production, they tend to produce less, and more of their crops are consumed within the family. [5] Estimates show that if productive inputs like fertilizer, manure, and labor could only be reallocated within the African household from men's to women's crops, in some societies the results could mean an increase in the value of household output of 10-20%.[6]

In most parts of Africa, farming for women means more than monetary rewards. African women consider farming for food as part of what makes them women and gives them a gender identity. The cultural categories of gender in Africa today usually link farming-female-food as a gender marker. [7] The analogy in Europe and the Americas is that women consider the cooking of food to be feminine and to define them as women, such that "A good woman is a good cook" is a norm many women learn during childhood when gender identities are first formed. In contrast, African rural women define themselves by their ability to wield a hoe and grow the food for the household. [8] For them, "A good woman is a good food farmer and a good cook."

Unfortunately, as Goheen points out for the case of Cameroon, ideology regarding gender categories has been a major stumbling block to women's access to resources, particularly to land. [9] The designation of women as primary food farmers/ providers used to encourage a relative equality and complementarity between male and female qualities, but with changing material conditions the complementary roles played by men and women have become much less equal. [10] "The contradictions in women's role as primary food farmers have deepened, and there is now evident a 'feminization of poverty'…" partly because government has institutionalized these cultural constraints and created *socio-legal* obstacles for women farmers. [11] Whereas previously, custom alone dictated that "men owned the land, women begged for it," now government under the pretext of land reform has put up many hurdles for new land acquisition. Only urban elites and "big men" can jump them and invest in land, leaving rural women on very small landholdings.

Another barrier for women is that cash crops (and cash activities in general) have long been considered part of the male domain in many African societies. Subsistence food crops, those not sold but consumed in the household, are usually considered part of the female domain. This means women food producers usually do not have access to money from the sale of cash crops in order to buy yield-increasing inputs. They are dependent on their husbands or sons to buy them fertilizer. Some agricultural experts claim this exclusion of women from cash cropping was changing even before structural adjustment reforms occurred in the early 1990s. In Uganda, women started to grow coffee while in Malawi women grew burley tobacco and new hybrid maize varieties. In Zambia, women were growing cotton. Yet in Malawi, wives of tobacco farmers claim that their husbands buy them a few dresses and keep the rest of the additional income from tobacco, irrespective of the amount of labor provided by the women. In Dowa, Malawi, the NGO VEZA/HODESA has a program directed at women only. Project staff report that husbands decide if and how much credit (in bags of hybrid maize harvested by both men and women) is repaid to the program, because hybrid maize is still considered part of the male domain. [12]

In many African societies, men and women do have separate income streams, and this gives some autonomy to African women. [13] Women's incomes, however, don't necessarily give them *power*, which usually accrues to the male household head. [14] The relative powerlessness of African women as compared to men is symbolized by their long hours spent head-loading water and firewood, their devotion to subsistence crops rather than cash crops, as well as their lack of political voice.

African women also tend to be "de facto" female household heads for some period in their lives, so that 25% of African households are female-headed households (FHHs) with relatively more autonomy and decision-making power in the household than women in male headed households (MHHs). [15] They are generally poorer than women and men in MHHs, however, and therefore less powerful in their rural communities. Due's data from Zambia and Tanzania show FHHs have less adult labor, less access to credit and smaller incomes than male headed households. FHHs plant smaller crop acreages, more subsistence crops relative to cash crops, and are not as productive as male-headed households. [16] Quisumbing notes this is not *directly* due to their gender, but rather their low incomes which prevent their purchase of "modern" yield-increasing inputs of production such as fertilizer, hired labor, etc. [17] Gladwin et al. claim that due to their relative poverty, FHHs have a greater tendency to be chronically food-insecure than do women and men in MHHs. Policy solutions should diversify and strengthen multiple livelihood strategies for FHHs. [18]

IMPACTS OF STRUCTURAL ADJUSTMENT PROGRAMS IN AFRICA

Due to their lower incomes, rural women and especially rural FHHs, are considered a vulnerable group. They are the first to suffer when a macroeconomic downturn or recession hits, and the last to recover from it. [19] Women in particular have borne the social costs of structural adjustment programs (SAPs) in sub-Saharan Africa. Because women are in charge of reproduction of the household, they suffer first when the costs of food, education, health care, and medicines rise due to government budget cutbacks mandated by SAPs. [20] Women are in charge of provisioning the household with food, so they suffer first when repeated devaluations of the local currency and the removal of fertilizer subsidies result in the rise of fertilizer prices making its use on hybrid maize varieties unprofitable and unaffordable. [21] As Uttaro (in this special issue) argues, women, who in the late 1980s and early 1990s changed maize varieties from unfertilized local varieties to new fertilized flint hybrids, are now being forced to switch back to local unfertilized varieties due to higher fertilizer prices. As a result, they again get lower maize yields and watch their granaries empty earlier in the hungry season. Because gender ideologies tell women they are the ones responsible for feeding the family, they especially suffer when the hungry season lengthens as a result of the changes they've been forced to make after structural adjustment "reforms." [22]

This is not to say that the "bitter pill" of structural reform in sub-Saharan Africa was unnecessary. By now, most observers realize that *globalization* demands changes in the way open economies formulate their macroeconomic policies and finance their budget expenditures. States can no longer hang on to an overvalued exchange rate and negative current account balance for very long. [23] Since the early 1980s, African governments have thus been forced to learn the rhetoric of stabilization, fiscal and monetary policies, and market liberalization measures.

The deflationary measures mandated by structural reform, however, have impacted most severely on women in African households, especially on FHHs. Because most FHHs are *net buyers* and not net sellers of food crops, they sell little if any of the export crops or tradables encouraged by SAPs. Therefore, they are unable to benefit from increased price incentives for tradables and market liberalization programs. [24] FHHs thus suffer when the price of food is allowed to rise making fertilizer use on food and cash crops once again profitable, especially if government has no safety net program in place to ameliorate the negative impacts of SAPs. They also suffer when safety net programs treat them not as producers but only consumers of food, creating more dependency on government handouts of the subsistence crop that they can grow themselves.

THE SOIL FERTILITY CRISIS AND AGRICULTURAL STAGNATION IN AFRICA

The impacts of structural adjustment programs on African women have been amply documented. Far less examined – except in this special issue of African Studies Quarterly – are the gender impacts of the soil fertility crisis in Africa, in part a result of structural adjustment policies. Noted agriculturalists such as Sanchez et al. claim that soil fertility is the number-one natural resource in Africa; yet its depletion on smallholder farms is the biophysical root cause of declining per-capita food production all over Africa. [25] Smaling et al. estimate that soils in sub-Saharan Africa are being depleted at annual rates of 22 kilograms per hectare (kg/ha) for nitrogen (N), 2.5 kg/ha for phosphorus (P), and 15 kg/ha of potassium (K). [26]

The evidence of Africa's declining food production is by now common knowledge: Africa's per capita food production growth rates have steadily decreased at two percent per year since 1960. In contrast, food production growth rates in China have recently soared. Aggregate data for the early 1990s for all developing regions show that China leads the developing world in per capita food production indices while sub-Saharan Africa trails all developing regions. Cereal yields follow the same trend: China's 1992-94 averages at 4482 kg/ha are the highest of the developing world and Africa's are the lowest (1023 kg/ha). [27] In contrast, sub-Saharan Africa's population growth rates 1990-1995 are the highest in the world at three percent per annum, while China's are now a low 1.4 percent per annum. These indicators show that Africa's per capita food production cannot keep up with its population growth rates. It is a continent of farmers that enigmatically imports one-third of its food grains— nine of its ten largest countries are net importers of food. Yet most African economies are agriculturally-based, with 75 to 80 percent of the labor force still employed in agriculture and most of the gross domestic product (GDP) still generated by the agricultural sector.

The impacts of this decline in agricultural productivity are likely to be particularly severe for African rural women, whose economic livelihoods are so closely linked to the production or sale of agricultural products and services. Because women are the main food producers in many African societies, they are also the key to *reversing the crisis* and increasing domestic food production in Africa. Yet their lack of power at the household, community, and national levels present constraints to national goals of food security not present in the 1960s and 70s when Asian and Latin American countries set out to achieve Green Revolution yields and thus transform their mostly agrarian economies. This is termed the *invisibility factor* in the African food security literature, most of which is de-linked from the women in development (WID) literature. Food security analysts correctly argue that to be effective development strategies need to reach African smallholders, but they ignore the fact that constraints facing women smallholders may be an important part of the problem. Eicher, for example, consistently fails to mention that 45% of the smallholders responsible for Zimbabwe's second Green Revolution (1980-1986) are women, nor does he indicate the percentage of hybrid maize adopted by women nor the percentage of fertilizer subsidies benefiting women. [28] Similarly, Smale's report on Malawi's *delayed* Green Revolution does not indicate women's adoption of hybrid maize. [29] Yet women's maize varieties (as shown here by Uttaro) are mostly local maize varieties, while hybrid varieties are mostly cash crops sold by men.

Reversing the alarming trends of declining food productivity is therefore the subject of the papers in this special edition, which treats gender relations as an important factor in the current crisis. Most authors agree that if governments' aim to increase food production, then they should improve the soil fertility and replenish the nutrients recycled out of producers' fields, who in Africa happen to be women farmers. But *how this can be accomplished* is the problem vexing most governments and donors.

WOMEN IN STRUCTURAL TRANSFORMATION

The main goal of development is to improve rural incomes and increase agricultural productivity so that Africa can "structurally transform" or diversify its currently agrarian economies, creating three complementary sectors including: a fledgling manufacturing sector, a larger services sector, and a gradually-diminishing agricultural sector. [30] This long-term process has been termed "structural transformation" because the process changes the entire economy, from the flow of goods to wage and profits patterns. Tomich et al. estimate it will take quite a long time to diversify an economy at the early stages of structural transformation, from an economy mostly dependent on agriculture to one with developed agricultural, manufacturing, and service sectors. [31] The time required for a *CARL* (country with abundant rural labor) to diversify its economic structure is related to the "structural transformation turning point," defined as the point in time when the absolute size of the agricultural labor force peaks and begins to decline. For African countries, which comprise most of the 58 countries now identified as CARLs this is an extremely important consideration because their high population growth rates, ranging from 2.5 to 4 percent per year, impede their reaching the structural transformation turning point – when the economy *begins* to diversify – any time soon. [32] For example, in countries with population growth rates of 3.3 percent per year and 75-80 percent of the labor force still in agriculture, Tomich et al. estimate that the time required for structural transformation ranges *from 32 to 58 years*, even given the most optimistic (5-6 percent) annual rates of growth of labor absorption from agricultural into nonagricultural sectors. Unfortunately, given these high population growth rates, the nonagricultural labor force cannot absorb enough of the total labor force to quickly decrease the size of the rural population dependent on agriculture for its income.

If diversification of a CARL takes this long, how realistic is it that African rural women can quickly acquire off-farm employment and thus significantly expand the scope of their nonfarm income-earning activities? Not very. Women farmers will need at least this amount of time to acquire formal off-farm employment—– more formal than the informal income generating activities they now perform, because rural women are the least educated and least connected to powerful people with nonfarm jobs in town. [33] African rural women will therefore have to rely on the more informal "small money" income-generating activities to create their cash income for a significant time to come. During this time period, some women, especially the FHHs, may need a *safety net* program to give them public assistance. Safety nets imply a process of moving from government programs that are open to all, regardless of income level, to programs where eligibility is related to poverty and the level of benefits is related to the level of poverty. This topic emerges again in Gough's article for this special edition. [34]

The articles in the special issue are thus more concerned about accelerating the long-term development process in Africa, and identifying how women fit into that process, than they are about guaranteeing *gender equity* to African women. While equity for rural women is a worthwhile goal in itself, it is not as urgent a problem in Africa today as the goal of bringing the whole continent out of the stagnation and despair that now engulfs it. [35] Immersed in what Chege calls "the paradigm of doom," Africa is presently inundated by gloomy reports about its civil wars, famines, high HIV infection rates, geographical isolation, chronic mismanagement, and negative or minimal growth rates. [36] This set of papers examines how governments and policy planners can increase women farmers' productivity and thus bring Africa closer to the structural transformation turning point, so that the continent as a whole can see the light at the end of the tunnel. Yet much confusion exists in Africa today, both about gender equity and about women's role in the process we term "structural transformation."

This is to be expected. In the 1960s and 1970s, Asians and Latin Americans were equally confused about the aims of small farmer projects, often associating them with a communist ideology. Similarly, many Africans are now confused about the goals of WID projects, and identify them with perceived attempts at hegemony by "Beijing women." The result is that thirty years after Ester Boserup first published *Woman's Role in Economic Development*, gender impacts on development are still poorly understood, as witnessed by the phethora of books about the topic from anthropologists, [37] geographers, [38] and political scientists. [39]

OBJECTIVES OF THIS SPECIAL EDITION

The purpose of the papers in this special edition is to help clear up some of misunderstandings about women's roles in increasing Africa's agricultural productivity and to outline ways African governments can use women farmers to bring their economies further along the path to structural transformation. The papers also summarize the results of the project known as "Gender and Soil Fertility in Africa," which was funded from 1997 to 2002 by the United States Agency for International Development (USAID) through the Soils Management Collaborative Research Support Project (Soils CRSP). In 1997 the authors of this edition began to explore, test, and compare the many different ways African governments, non-governmental agencies (NGOs), private volunteer organizations (PVOs), and agricultural research/extension centers (CGIARs and NARs) can improve the soil fertility on women farmers' fields and gardens devoted to their food crops. The different policy options African governments can use to reach or target women farmers include:

- improve women's access to chemical fertilizers via introducing *grants or vouchers* targeted directly at women farmers, especially women in the poorer FHHs

- improve women's access to chemical fertilizers by encouraging the introduction of *small bags* of fertilizer in local shops or market stalls, or sales of fertilizer by the kilogram

- improve women's access to inorganic fertilizers by introducing *credit* or *microcredit* for fertilizer to women farmers

- improve women's access to biological nitrogen fixation (BNF) technologies via *agroforestry* innovations or *grain legumes* to women farmers

- improve the *soil organic matter* on women's fields for their food crops via *green manures* or biomass transfer

- introduce a *cash crop* into women's cropping systems whereby women farmers can pay for fertilizer use on their food crops with cash-crop receipts

- introduce any combination of the above

SOLUTIONS INVOLVING USE OF INORGANIC FERTILIZER

Vouchers

Target support for small amounts of fertilizer in the form of vouchers directly at cash-poor women farmers producing food crops. A voucher system would allow an African government burdened with fiscal deficits to do something about food security by targeting the subsidy directly at women farmers who produce most of the food. This would also encourage healthy competition between private distributors in the fertilizer industry. With such a voucher system, members of women's clubs would receive vouchers to take to private distributors, from whom they would buy fertilizer at a discount. The government would then remunerate distributors for the vouchers. In this way, the government's physical presence in the fertilizer distribution system would be minimized, and its total subsidy bill would be less than when fertilizer subsidies were freely extended to all growers of food and export crops, men and women alike.

The vouchers would be discontinued after a number of years. Women would buy fertilizer from local merchants on the open market at the market price, with or without credit. The temporary program of vouchers would be coupled with a plan for supervision of women's application of fertilizer in order to reduce leakages (the use of vouchers for crops other than women's). The plan would also strengthen the revolving credit funds used by many women's clubs to bail out individual defaulting members. Clubs would receive a stipend to supervise the application of vouchered fertilizer on women's fields. Women's clubs can thus serve not only to expand credit to women but also to supervise the proper use of fertilizer vouchers.

Donors like the World Bank, however, have spent the last ten years removing fertilizer subsidies. Their policy now is to move to full market cost of fertilizers. [40] In fact, most food policy analysts recommend that input subsidies, and particularly fertilizer subsidies, should be eliminated entirely because they are a common technique used to increase the profitability of intensive agriculture while keeping food prices artificially low. [41] Only when total fertilizer use is low and the ratio of incremental grain yield to fertilizer application is high can such subsidies be cost-effective, relative to higher output prices or greater food imports. African governments burdened with large fiscal deficits should therefore consider whether fertilizer subsidies represent the best use of their limited resources. After all, *someone must pay for the subsidy*. Economists thus conclude "all subsidies tend to distort the intensity of use of inputs from their economically optimal levels, and significant waste is a result. Since not all inputs can be equally subsidized, output price increases will have a greater impact on productivity than will input subsidies, especially in the long run". [42]

This line of reasoning makes sense when applied to Asia and Latin America today. But it did not make sense during the eras of their Green Revolutions in the 1960s and 1970s, when fertilizer use contributed fifty to seventy-five percent of the increase in yields in food crops. [43] At that time the adoption of fertilizer-responsive "modern" varieties depended on fertilizer subsidies. [44] This line of reasoning does not apply to current conditions in sub-Saharan Africa where average fertilizer use — not nutrient use — is a mere seven to eleven kg per ha, and women food producers commonly use no fertilizer. [45] Larson and Frisvold conclude that average fertilizer application rates in Africa need to increase from ten kg per ha to fifty kg per ha within ten years (an eighteen annual growth rate) to prevent mining of soil nutrients. [46] Yet due to the current high price of inorganic fertilizers, farmers are now forced to extensify their agricultural practices and clear relatively unused areas (forests and old bush) to increase total output, rather than intensify their land use. This has led to a loss of biodiversity of aquatic as well as woody species. Hence near-term environmental concerns in Africa stem more from the persistent decline of soil fertility rather than from an over-use of fertilizers.

Policy interventions are thus needed to encourage women food producers to increase their yields of traditional as well as modern varieties; and fertilizer subsidies in the form of vouchers are the most direct policy tool planners have at their disposal to do that. [47] From the viewpoint of the women farmers, such vouchers are preferable to an expansion of credit opportunities because women face many more constraints to credit use than men. They are either too poor, too old, or lack control over a cash crop with which they can repay a fertilizer loan. [48] Without a cash crop, the risk of borrowing is particularly high for women, because they probably have to sell some of their subsistence crop in the hungry months and deny their children food in order to repay the loan. Rather than take that risk, they will often decide not to get credit, not to use fertilizer, and not to increase their yields.

Fertilizer subsidies delivered by means of vouchers can decrease this risk for resource-poor women farmers and thereby play an important role in increasing their yields and productivity. [49] Some agricultural economists agree. Eicher, for example, accuses the donor community of failing to present a balanced view of the substantial role subsidies played (and still play) in Asia's Green Revolution. He points out that, "currently donors in Africa are focused on a number of policy reforms such as correcting overvalued exchange rates and removing fertilizer subsidies rather than long-term, institution-building activities, the hallmark of donor assistance in Asia in the 1960s and 1970s. In their zeal to remove fertilizer subsidies in Africa, however, some donors are neglecting to inform African policy makers about the role of subsidies in Asian agriculture." [50]

Pinstrup-Anderson claims that fertilizer subsidies can serve as a temporary measure to compensate for the factors that make it difficult for African (as opposed to Asian) entrepreneurs to freely compete in an open fertilizer market. [51] Among these factors are:

- the small volume of fertilizer that most African countries import, which weakens their bargaining position in negotiating for lower prices

- high transportation costs within most African countries

- high storage costs, which increase the expense of fertilizer distribution

- unpredictable government policies and unstable institutions which scare off private entrepreneurs from investing in input distribution systems

- the relative ease of government's acquiring fertilizer in the past as foreign aid the tendency of governments to maintain large fertilizer stocks, which may be released anytime and at any price and thus upset a private distribution system.

Pinstrup-Anderson concludes that governments should privatize fertilizer distribution in a way that assures competition. Ootherwise, the private sector fertilizer distribution system may be no more efficient than the public sector system it replaced. If monopoly profits accrue, it will actually be more expensive. He also believes fertilizer prices can only be brought down if, in the long run, governments invest in the infrastructure to reduce transportation and marketing costs. But until they do, "there is a place for fertilizer subsidies" to compensate for the factors resulting in very high fertilizer prices. [52]

Small Bag Option

Improve the availability of small amounts of fertilizer in local markets and shops by repackaging 50 kg bags. Since most fertilizer for family food production must be carried both to the home as well as to the food plots, the weight of the bag is an important issue. So is the amount of cash or credit needed for the purchase. Due to its high cost today in Africa, few farmers can afford to buy a 50-kg bag of fertilizer. It no longer is a divisible input in Africa. Further, the cost of transporting fertilizer from the market to the home and/or field is also a factor in the scope of its use. Having fertilizer available in smaller bags would make it both more affordable and easier to carry.

The small-bag strategy is compatible with the views of many economists who believe that *accessibility* of fertilizer is the main constraint to its increased use. [53] If fertilizer were widely sold in local markets like cement and available in weights that could be headloaded home, women farmers would be more likely to buy it. Also, small bags reduce the risk associated with open bags of fertilizer absorbing moisture and becoming difficult to store over several months. For these reasons, the sale of fertilizers in five-, ten-, and twenty-kilogram bags at local markets should increase fertilizer use by women farmers.

As shown by Uttaro's paper in this edition, however, there are some negative features of small bags of fertilizer. One is their lack of availability in all but the biggest market centers. Another is the higher costs per kg of the fertilizer. Making small bags available assumes that fertilizer distributors in Africa today would be willing to bulk-blend imported fertilizers and assemble the product in smaller bags in Africa, rather than directly importing the bagged fertilizer. Finally, there are higher transactions costs for a smaller bag because the cost of the bag itself as well as the labor costs of bagging would have to be spread over only twenty-five kg rather than fifty kg of fertilizer.

Uttaro points out that one way around this is for fertilizer distributors to sell fertilizer "by the kg" and cut contents of a fifty-kg bag of fertilizer into smaller amounts. While this has been done, distributors sometimes have added other inputs to the smaller bags, e.g., sand. Farmers are now very skeptical of local traders who sell fertilizer in smaller amounts. What is needed in now needed in Malawi, according to Uttaro, is to build farmers' trust that they will get "an honest kg for an honest kwacha."

Microcredit Option

Expand the fertilizer credit market for women farmers via community banks operating on the Grameen Bank model. The Grameen Bank in Bangladesh targets very small loans to groups of virtually landless women producers. [54] With two million borrowers and a recovery rate of more than 90%, it is clearly a compelling model. By 1994, it served half of all villages in Bangladesh, lent about US$ 385 million, and mobilized another US$ 306 million as savings and deposits. [55] The bank is unique in that its explicit goals are to alleviate poverty and create self-employment opportunities for illiterate people (who own less than half an acre of land and have never received a loan from the formal financial system). Since 1985, it has specifically channeled credit to women, who are less empowered among the rural poor. Increasingly, women receive the bulk of the loans and are the majority of the members. Their share of total cumulative disbursement rose from a little more than half in 1985 to 91% in 1994. Female membership grew from 65.5% of the total in 1985 to over 94% in 1994. [56] Strict observance of the norms forces group members to be accountable to each other. Based on a group of five, the first two women to receive credit must repay regularly for others to obtain loans. The group leader is customarily the last to receive credit. This creates pressure among group members to enforce the contracts, screen out bad borrowers and encourage savings. In 1994, women's savings amounted to 74% of total savings mobilized. [57]

What lessons can Africa learn from the Grameen Bank? The first lesson is that a bank with poverty-alleviation goals can also be sustainable as a bank by lending at market interest rates. The Grameen's lending rate has been twenty percent since 1991. [58] Its subsidy dependency index (SDI) has decreased over time from 180% in the 1980s to 36% in 1994. [59] The second is that women are often better credit risks than men, since loan recovery rates for general loans have been higher for women (97% in 1992) than for men (89%). [60] Whether it can be replicated in Africa is now being tested by Sasakawa Global 2000 programs such as Benin's CREPs (Caisse Rurale d'Epargne et de Pret) that mobilize savings before loaning to farmers, twenty percent of whom are now women. [61]

Free Bag Option

For a short time only, introduce a system of grants – or safety net program -- of small bags of fertilizer targeted at the poorest women farmers. The term *safety net* refers to programs that attempt to address a food consumption deficit in households of either the chronically poor and food insecure or the transitory food insecure. In cases of chronic food insecurity, safety nets are targeted at the poorest quintile or two (and rarely three) of the population, and would thus include the majority of FHHs. In Malawi, for example, the poor comprise forty-one percent of rural households, forty percent of whom are female-headed. Except in rare cases of severe drought or devaluation, safety nets should *not* be given universally as were Malawi's "starter packs" in 1998-2000. [63]

The advantage of safety net programs, as opposed to subsidies, is that they can work through the markets instead of disrupting them. There are several kinds of safety nets that satisfy this criterion: "food-for-work" programs, public employment programs, "inputs-for-work" programs, and "vouchers-for-work" programs. If they are also "productivity-enhancing safety nets (PES-nets)," then they target the people who are food insecure while *not* detracting from the national goal of increased productivity to move the country as a whole toward structural transformation. Devereux points out why a safety net program should also strive to increase productivity in Africa. Because African food insecurity is caused by *low productivity*, it is "best addressed by interventions to raise returns to effort" instead of merely using food transfers to bridge a consumption deficit. "Reducing production or income deficits is a pre-emptive strategy to reduce consumption deficits, thereby minimizing the need for safety net interventions." [64] Safety nets that provide consumption support to people below the poverty line – especially farmers who know how to produce their own food, "have no beneficial impact on livelihood systems," divide the poor into "workers" and "dependents," are not sustainable, and merely deepen dependency.

PES-nets in the form of public works programs will improve the food security of participating households if the time spent on them does not conflict with food production activities. However, public works programs typically focus on male tasks (e.g., rebuilding roads, bridges and water canals, reforestation projects), and thus employ mostly men. To benefit poor rural women public works programs should also include tasks that women typically perform, such as communal gardening, caring for communal (agroforestry) nurseries, soil conservation programs, care of the sick or orphans of AIDs (a task usually left to grandmother-FHHs), and care of the communal water kiosk, rubbish disposal pit, or soak-away pit. Public works programs could also remunerate men's and women's participation in group training sessions about family planning, literacy, and crime prevention. The definition of "work" in "food-for-work" programs needs to be broadened, and the definition of remuneration-for-work should be expanded. Female participation rates are higher (sixty percent vs. twenty percent) when food payments are offered as opposed to cash wages in Malawi's public works projects. [65]

For women farmers, the most optimal PES-net would be fertilizer vouchers received for work in "fertilizer-for-work" programs, (as suggested by Anderson's paper in this special issue), because they are more cost-effective than programs offering a food wage and do not deepen dependency. In Malawi, the current nitrogen to hybrid-maize price ratio is now so high that only small amounts of fertilizer (e.g., 37 kg/ha of nitrogen) are still profitable or "optimal" for food production. [66] At these low levels of fertilizer, however, the response from an additional kilo of nitrogen is high. [67] Therefore, the cost of maize to the farmer growing her own maize with fertilizer is *much less* than the market price of maize. This means that a safety net program that gives a fertilizer voucher, redeemable from any private fertilizer distributor, should be more effective than one exchanging food (maize) for work . [68] This is supported by Tsoka and Mvula whose results show that the majority of rural residents in southern Malawi (both FHHs and MHHs) prefer payment from public work programs in fertilizer rather than in cash or food. [69] "The evidence is overwhelming: the rural poor in Malawi see access to agricultural inputs as a priority, and inputs-for-work for part of the year as a means of obtaining fertilizers and seeds. [70]

The disadvantage of a safety net program in Africa is that numbers of targeted clientele may be substantial. Kumwenda et al. estimate the food insecure comprise forty percent of the smallholder population in Malawi. [62] Another concern that has been raised is that farmers might *sell* the fertilizer given to them as a safety net, rather than apply it to their food crops. For example, some of the fertilizer starter packs that were distributed in Malawi in 1998/99 were sold by farmers who desperately needed the cash. [71] To see the impacts of this activity, Anderson's paper models the situation of a poor FHH that sells a 25-kg bag of fertilizer granted for K100. Anderson's example, based on linear programming modeling, shows that although some farmers are desperate enough to sell grants of fertilizer and other inputs, their livelihood systems are unsustainable as a result.

SOIL ORGANIC INPUTS AND BIOLOGICAL NITROGEN FIXATION OPTIONS

Women's constrained supply of cash, together with the removal of price subsidies on fertilizers and rising costs may compel a majority of them to rely only on organic sources of nutrients -- especially legumes that fix atmospheric nitrogen — as the only available strategy for increased soil fertility. At current levels of availability and use, however, "organic inputs are rarely sufficient to meet crop demand for nutrients or maintain soil organic matter." [72] The use of inorganic fertilizer can be supplemented or enhanced with use of organic sources of nutrients increased considerably by enhancing the level of soil organic matter. [73] Therefore the following are possible options for getting organic nutrients to women farmers.

Soil Organic Matter Option

Make soil organic materials of farm origin more accessible. In addition to serving as sources of nutrients, organic materials can influence nutrient availability by:

acting as an energy source for soil microbial activity

serving as precursors to soil organic matter

influencing the release pattern of plant-available nutrients

reducing phosphorus sorption of soil.

In on-farm trials, options would include use of green manure, animal manures, improved fallowing, biomass transfer, and legumes as sole crops in rotation or intercropped with cereals. [74] Information can be diffused via extension workshops, field days for women, and gender "training of trainers" for extension agents. Microcredit programs can be used to improve access to organic inputs for women farmers.

Biological Nitrogen Fixation Options

Make biological nitrogen fixation technologies more accessible. Nitrogen-fixing technologies involve crops grown in rotation with maize such as velvetbean [*Mucuna pruriens* (L.)], pigeonpea [*Cajanus cajan*], sunnhemp [*Crotalaria juncea*], lablab bean [Lablab purpureus], and crotalaria [*Crotalaria ochroleuca*], as well as trees and shrubs used in new agroforestry technologies (such as hedgerow intercropping, biomass transfers, and improved fallow technologies). These nitrogen-fixing technologies can be promoted by making seeds, seedlings, and extension education more accessible to women farmers. ICRAF researchers and World Vision extension agents are now doing this in eastern Zambia and Malawi, as well as in western Kenya and Uganda. Other examples are the "doubling-up legumes" technology tried in central and southern Malawi, where land is too scarce to take it out of production to plant a tree or shrub in an improved fallow. [75] By experimenting with women farmers' test plots that intercrop two different types of legumes (e.g., pigeon pea and groundnuts) or rotate legumes with cereals, Snapp has shown that women farmers can improve both legume and cereal yields. Giller et al. conclude that nitrogen-fixation from legumes can sustain tropical agriculture at moderate levels of output, often doubling those currently achieved. [76]

Organic-Inorganic Options

Make combinations of organic and inorganic inputs in small amounts more accessible. Organic materials are frequently in limited supply and hence cannot by themselves provide the productivity boost needed by African smallholders. [77] The combination of available organic materials with small amounts of inorganic chemical fertilizers may be a very appropriate option for women smallholders, especially the poorer FHHs. [78] Unfortunately, none of the studies here found a naturally-occurring experiment that formally tested this option. Where inorganic fertilizers were used, they were in combination with some maize stover and weeds, usually turned under when farmers ridge their fields prior to planting. Unfortunately in most cases, not much organic material in the fields is still green when farmers make their new ridges for the next year.

Cash Crop Option

Introduce a cash crop into women's subsistence farming systems. Sustainable food production is an important goal of development, but only when women farmers obtain *cash* will they have a sustainable way either to buy food and cash inputs or repay loans. Cash cropping on a small portion of women's land normally devoted to subsistence crop(s) can be encouraged by women's clubs such as Malawi's Tikalore Clubs or tobacco clubs. These clubs give fertilizer credit to women for both food and cash crops. The loan is repaid from proceeds of the cash crop. Credit programs for food crops alone should not be recommended at adverse fertilizer-food crop price ratios, because their use will only result in a negative debt spiral. However, when women get fertilizer under credit schemes intended to improve cash cropping, they should be free to decide to which crops they apply the fertilizer, as farmers are often better judges of the markets and risks than outside analysts. Government can encourage women earning cash income by expanding microcredit/ microenterprise programs for women, which allow them to acquire credit for whatever income-earning activity they desire, whether a farm or nonfarm enterprise. All these programs should recognize the interdependencies between women's subsistence food production and income-earning opportunities. In Malawi, for example, women farmers are now growing burley tobacco (*Nicotiana tabacum* L.) and using its receipts to pay back loans for fertilizer use on both subsistence maize and tobacco. [79]

THE UNIVERSITY OF FLORIDA SOILS CRSP PROJECT

Clearly, an African government can encourage any of these different policy options, and one may work better than others in a particular locale. Given the extremely heterogeneous agroclimatic and socioeconomic conditions in Africa, the authors in this special edition focused on several naturally-occurring experiments in which an African government, NGO, or agricultural research center tried to reach women farmers. We did not attempt to manage a research or extension project ourselves. Nor did we plant on-farm trials (due to limited funding). Nor did we try to revisit the issues of how to improve extension services for women farmers. [80] Instead, we selected particular regions in several African countries and monitored projects already in operation, to assess the efficacy of methods to target women farmers there with soil fertility amendments. Most of the articles here should therefore be considered *case* studies or *micro-level* studies in particular regions that might not have been representative of the entire country, and certainly not the entire continent. At the end of the five-year project, we had done five separate micro-level studies in Malawi (of which four are presented here), three in Uganda (of which two are presented), four in Zambia (two are presented), and one in Ethiopia, Kenya, Senegal, and Zimbabwe. Therefore, our focus was mainly on southern and eastern Africa.

Nevertheless, results from the micro-level studies give some indication of the popularity and efficacy of the various strategies to target women farmers in Africa. We found, for example, almost no use of fertilizer vouchers in all the projects we monitored. Gough's paper is the only study of fertilizer voucher use in Malawi's Starter Pack program of 1998-2000, an input grants program designed to give every rural household in Malawi small quantities of chemical fertilizer, hybrid maize seed, and legume seeds as a safety net. Similarly, sales of small bags of fertilizer in local markets and shops are rare, and only examined by Uttaro's paper. Credit use for fertilizer was also infrequent, partly due to the collapse of credit institutions during the structural reforms and droughts of the 1990s. But it is examined by Sullivan's and Anderson's linear programming models in this edition. In contrast, agroforestry innovations in the form of biomass transfers, and especially improved fallow technologies, were the subject of much innovative research by biological and social scientists in Kenya, Uganda, Eastern Zambia, and Malawi. These are discussed here in papers by Gladwin et al. and Thangata et al. Similarly, research on grain legumes that fix nitrogen was popular and promising in Africa during 1997-2002, and is described by Gilbert et al. and Mudhara et al. Indeed, both these biological nitrogen fixation technologies were more frequently seen than animal manure use in the micro climes and regions we focused on. The reduction in manure use as an organic fertilizer, due to a decline in grazing land and decreased cattle production, is described by Dougherty for southern Ethiopia; but the decline in its use was also observed in Malawi, Zambia, and Zimbabwe. Notable in all the papers, but especially in papers by Nkedi-Kizza et al., Goldman and Heldenbrand, and Uttaro, is the ubiquitous decline in farmers' use of chemical fertilizer since the start of structural adjustment reforms. This last topic, and the resulting decrease in agricultural productivity of both women and men farmers, is unfortunately the one common thread seen in all the papers of this special edition.

The methodologies employed by these authors to assess the efficacies of various methods to target women are also diverse. This was done purposefully, so that our results might be robust across a variety of methodologies, and speak to researchers across disciplines in the bio-physical, environmental, and social sciences. This diversity also reflected the multi-disciplinary nature of our research team. At the faculty level, the team consisted of an agricultural economist, one agricultural economist/ anthropologist, one geographer, two agronomists, and one soil scientist. We were also fortunate to attract graduate students from anthropology, economics, agricultural education and communications, geography, conservation and natural resources, and political science. Given this diversity, we wanted the micro-level studies to complement each other, if possible. So this collection of papers does not focus on any special methodology. As a result, four of the papers in this collection use ethnographic linear programming (LP) modeling, two papers use ethnographic decision-tree modeling, two papers use consumer-to-producer ratios a la Chayanon, one paper uses scripts, one paper uses geographical surveys, and one paper uses soil sampling techniques. All use personal ethnographic interviews to some extent.

PREVIEW OF OUR CONCLUSIONS: HOW TO TARGET WOMEN FARMERS AND INCREASE FOOD PRODUCTIVITY IN AFRICA

Unfortunately, our conclusions do not paint as rosy a picture as this heading suggests. We did not find easy answers to the question of how to target women farmers, replenish their depleted soils, and thus increase their productivity, especially on fields planted to food crops. Instead, we sometimes found that the policy options expected to work are not viable options for women to improve their soil fertility, even though they worked for men. In other locations, we found that options that worked for married women in MHHs did not work for FHHs, usually poorer than married women. In all the sites, we found location-specific and historical conditions made it difficult to generalize results across all the micro climes. Yet, in order to preview the more complicated stories presented in this special edition, the following is a brief summary of our conclusions:

> Fertilizer voucher distribution is almost non-existent in Africa. We did not find a naturally-occurring experiment in which to assess fertilizer vouchers targeted at women food producers.
>
> Small bags in local shops are bought by both men and women in MHHs, but are usually used on men's cash crops rather than on women's food crops. Small bags are rarely bought by FHHs. Fertilizer in local markets, unlike cement, is rarely sold by the kilogram.
>
> Credit targeted directly at women is problematic. For women in MHHs, it leaks to men in locations where cash income is the man's domain. Women use informal credit more

than formal credit. Household composition also affects credit use as FHHs are still considered bad credit risks.

Grants of fertilizer targeted only at the poorest FHHs did not occur in Africa. Vouchers for grants of fertilizer are problematic when grants are universally distributed.

Women plant grain legumes for food and do not plow them under when green, so they do not usually serve as a soil fertility amendment in Africa.

Lack of land, labor, awareness-knowledge, and technical-knowledge limit women's adoption of agroforestry innovations. Where land is available and extension efforts alleviate the lack of knowledge constraints, poor FHHs do test and adopt improved fallow technologies (even more so than married women in MHHs).

Combinations of small amounts of chemical and organic fertilizers may show promise. But once again, we did not find a naturally-occurring experiment disseminating innovative new combinations of inorganic and organic fertilizers in a formal manner, and so we could not study this option.

Women's access to cash crops does not ensure their use of soil-fertility amendments, but does help relieve women's cash constraints so that cash-allocation decisions may be made about fertilizer use. In locations where women receive fertilizer credit for cash crops, they usually use some of it on their food crops.

Given this list of rather bleak findings, we conclude that married women, like men in MHHs, do have some good options for improving their soils: small bags of inorganic fertilizers, fertilizer sold by the kg in local markets, microcredit programs for fertilizer use, safety-net programs, more cash cropping, and organic options (including legumes and agroforestry innovations). For these women, government should encourage market-liberalization programs that include women, as well as men, as the targeted clientele. For example, private traders of cash crops should be encouraged to buy directly from women; private stockists of fertilizer should be urged to carry small bags of fertilizer in local shops and markets, and extension programs that target women should be supported.

But African women farmers are not all alike. For the poorer FHHs, the options are fewer because their resources of land, labor, and capital are less. In our opinion, their soil-fertility options boil down to safety net programs, cash cropping, and nitrogen-fixation technologies (improved fallows or doubling-up legumes). This is because FHHs do not have the access to cash or credit to acquire chemical fertilizers. For these women and thus twenty-five to thirty percent of African households, if improved fallow technologies do not diffuse or markets for cash crops fail, soil fertility improvements will have to come in the form of safety net programs.

These findings do not bode well for the future, given Africa's limited set of resources and its relative inexperience with safety net programs. The design and implementation of safety net programs in Africa is a complicated business at best and a political minefield at worst. When grants are universally distributed, their benefits are too small to significantly increase household cash incomes. When they are directly targeted at female-headed households, local men use existing power asymmetries to gain some measure of control over these resources. As one reviewer suggested, it might be simpler to target safety net programs to very poor and poor households, most of which are *de facto* or *de jure* female-headed anyway. Yet, as the majority of smallholder farmers, women need to be better supported in their role as farmers if Africa is to ever experience a "Green Revolution" transformation. Perhaps gender-sensitive safety net programs that recognize women as agricultural producers, rather than simply as poor consumers or helpless victims, will be worth the effort.

Notes

1. Boserup 1970.
2. Dixon 1982, Gladwin and McMillan 1989.
3. Due and White 1986, Due 1991.
4. Quisumbing 1996.
5. Due and Gladwin 1991, Gladwin 1996, 1997.
6. Udry 1996. In Malawi in 1996/97, for example, an across-the-board 20% increase in household maize yields would have meant an increase in aggregate maize yields of 180,000 metric tons. With the price of maize now valued at Malawi Kwacha 24.00 per kg, up from MK 1.55 per kg in 1997, this would now mean an enormous savings in the costs of importing maize. The impact of these findings is thus quite large -- in savings of import costs of food crops -- if governments would only adopt policies to reach African women farmers with productive inputs for their food crops.
7. Goheen 1991: 240.
8. Moock 1986.
9. Goheen 1991, 1996.
10. Kaberry 1952
11. Goheen 1991:241.
12. D'Arcy 1997.
13. Polly Hill 1963, Gladwin 1976, Gladwin and McMillan 1989.
14. Ensminger 1987.
15. Due 1991: p. 103.
16. Due 1991:107.
17. Quisumbing 1996.
18. Gladwin et al. 2001.
19. Elabor-Idemudia 1991.
20. Meena 1991.
21. Bumb et al. 1996, Gladwin 1991.
22. Goheen 1991, Uttaro 1998.
23. Henderson 1998.
24. Mehra 1992.
25. Sanchez et al. 1997.
26. Smaling 1997: 521997: 52.

27. FAO 1998.
28. Eicher 1982, 1995.
29. Smale 1995.
30. Tomich, Kilby, and Johnston 1995.
31. Tomich et al.1995:14.
32. Tomich et al. 1995: Table 1.
33. This length of time is also required for a country to develop strong reliable markets and a distribution system in food crops that rural people can depend on, as well as the physical and governmental infrastructure to support them. One year of poor harvests and no food crops in the markets is all it takes for confidence in the markets, infrastructure, and government to plummet. In the following seasons, women will decrease cash crop production and revert to subsistence farming.
34. Deaton 1980, Bezuneh et al. 1980.
35. Chege 1997: 552.
36. Sachs 1997.
37. Bay 1982, Sacks 1982, Clark 1994, Davison 1988.
38. Rocheleau 1995, Thomas-Slayter and Rocheleau 1995.
39. Parpart and Staudt 1989; Gordon 1996.
40. Donovan, 1996; Saito et al. 1994.
41. Timmer et al. 1983, p.288.
42. Timmer et al., 1983, p. 288.
43. Byerlee and Heisey, 1992.
44. Harris, 1984; Van der Eng, 1994; Eicher, 1995; Goldman and Smith, 1995.
45. Lele et al. 1989.
46. Larson and Frisvold 1996.
47. Gladwin, 1991, 1992.
48. Gladwin, 1992, 1996.
49. Gladwin, 1997.
50. Eicher 1995: 807b, World Bank 1994.
51. Pinstrup-Anderson 1992: 106.
52. Pinstrup-Anderson, 1992: 105.
53. Lele et al., 1989.
54. Von Pischke, 1991 p. 233; Khandker et al., 1995.
55. Khandker et al., 1995, p.: xi.
56. Khandker et al., 1995, p.: 25-26.
57. Khandker et al., 1995: p. 31.
58. Khandker et al., 1995, p.: 66.
59. Yaron, 1992, 1996.
60. Khandker et al., 1995, p.: 18.
61. Galiba, 1996.
62. Kumwenda et al. 1996: 21.
63. Mann 1998, Longley, Coulter, and Thompson 1999, Gough in this edition.
64. Devereux 1999: 57.

65. Dil 1996.
66. Only small amounts of fertilizer (e.g., 32-37 kg/ha of nitrogen from calcium ammonium nitrate or CAN) are still profitable for food production (Benson 1997). These figures assume the farmer gets no credit for food crops, pays Malawi Kwacha (MK) 700 per 50 kilo bag of CAN, and the price of maize is a high MK 6.5, a four-fold increase from its previous price of MK 1.5 in 1997. The price ratio of nitrogen to maize is thus 10.5 with these assumptions. It also assumes farmers take risk into account, rather than maximize profits, so that they use inputs only up to the point where the value of the inputs is greater than or equal to *twice* their costs. Using these conservative assumptions, the risk averse farmer should apply 32 to 37 kg/ha of nitrogen per hectare.
67. Using Benson's response function for nitrogen on maize from 1600 on-farm trials conducted in Malawi in 1995/96, we calculate that with the optimal amount of 37 kg Nitrogen per hectare, a farmer gets roughly 26 kg maize from 1 kg of nitrogen, a very high response rate, if she does not count her own labor as a variable cost (a common assumption for smallholders). With CAN costing MK 14 per kg, one kg of Nitrogen costs MK 68.3, meaning the cost of a kilo of maize for a farmer growing her own is only MK 2.62, much less than MK 6.5, the cost if she were to buy it. For this reason, farmers realize they need chemical fertilizer, and it has become a political football in the politics of Malawi (Uttaro, personal communication).
68. An example is the fertilizer-for-work program initiated by Stephen Carr (1997) with the EU in 1991/92 when 10,000 tons fertilizer were distributed in a pilot program. Field assistants contacted local communities to ascertain what the community or village wanted done (e.g., more classrooms, wells, access roads, or teachers' houses). In June and July when the harvest was in and there was plenty of food, and school was out, village women would provide the labor to build a teacher's house in return for a fertilizer voucher that they could cash at planting time in November-December.
69. Tsoka and Mvula 1999.
70. Devereux 1999: 58.
71. Longley et al. 1999, Gough 2002.
72. Palm et al. 1997; Kumwenda et al., 1996: 9.
73. Palm et al., 1997, Kumwenda et al., 1996: 24.
74. Palm et al. 1997, Giller et al. 1997, Wortmann and Allen 1994.
75. Snapp 1999.
76. Kumwenda et al., 1996: 9.
77. Kumwenda et al. 1996: 5.
78. Palm et al., 1997; Kumwenda et al., 1996: 25.
79. Brown et al., 1996; Stephen Carr, personal communication, Anderson in this edition.
80. Staudt, 1975; Olayiwole 1991.

References

Bay, E. Women and Work in Africa. Boulder, CO: Westview Press,1982.

Benson, T. "The 1995/96 Fertilizer Verification Trial - Malawi." Report by Action Group I, Maize Productivity Task Force, Ministry of Agriculture and Livestock Development, Government of Malawi, Lilongwe, Malawi, 1997.

Bezuneh, M., Deaton, B.J., and G.W. Norton. "Food Aid Impacts in Rural Kenya." American Journal of Agricultural Economics 70 (1988): 181-191.

Boserup, E. Woman's Role in Economic Development. New York: St. Martin's Press, 1970.

Brown, D.G., S. Reutlinger, and A. Thomson. "Malawi: Food Security in a Market-Oriented Economy." Lilongwe, Malawi: Research report no. 1011, Agricultural Policy Analysis Project, Phase III (APAP III), USAID Contract No. LAG-4201-Q-16-3061-00, 1996.

Byerlee, D., Heisey, P.W. "Past and Potential Impacts of Maize Research in Sub-Saharan Africa: a Critical Assessment." Food Policy 21 (1996): 255-277.

Bumb, B.L., Teboh, J.F., Atta, J.K., Asenso-Okeyre, W.K. "Policy Environment and Fertilizer Sector Development in Ghana." Paper presented at the National Workshop on Soil Fertility Management Action Plan for Ghana: Efficient Soil Resources Management: A Challenge for the 21st Century, Cape Coast, Ghana, July 2-5, 1996.

Carr, S.J. "A Green Revolution Frustrated: Lessons from the Malawi Experience." African Crop Science Journal 5 (1997): 93-98.

Chege, M. "Paradigms of Doom and the Development Management Crisis in Kenya." Journal of Development Studies 33 (1997): 552-567.

Clark, G. Onions are My Husband. Chicago: University of Chicago Press, 1994.

Davison, J. Agriculture, Women, and Land: The African Experience. Boulder, CO: Westview Press, 1988.

D'Arcy, R. "Gender and Soil Fertility in the VEZA/HODESA Program of Malawi." Gainesville, FL: Report to the Gender and Soil Fertility Soils CRSP, 1998.

Deaton, B.J. "Public Law 480: the Critical Choices." American Journal of Agricultural Economics 62 (1980): 988-992.

Devereux, S. "Making Less Last Longer: Informal Safety Nets in Malawi." Institute for Development Studies Discussion Paper 373. Brighton, UK: Institute for Development Studies, 1999.

Dil, L. "Rural Appraisal: Primary Schools, Vulnerable Group Feeding, and Food for Work as Channels of Maize Distribution." Lilongwe, Malawi: World Food Program, 1996.

Dixon, R. "Women in Agriculture: Counting the Labor Force in Developing Countries." Population Development Review 8 (1982): 558–-559.

Donovan, W.G. "Agriculture and Economic Reform in Sub-Saharan Africa." Africa Technical Department, Environmentally Sustainable Development Division (AFTES) Working Paper Numbero. 18. Washington, D.C.: The World Bank, 1996.

Due, J.M. "Policies to Overcome the Negative Effects of Structural Adjustment Programs on African Female-Headed Households," in: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers, p. 103-127. Gainesville, FL: University of Florida Press, 1991.

Due, J.M., and C.H. Gladwin. "Impacts of Structural Adjustment Programs on African Women Farmers and Female-Headed Households." American Journal of Agricultural Economics 73 (1991): 1431-1439.

Due, J.M. and M. White. "Contrasts Between Joint and Female-Headed Farm Households in Zambia. Eastern Africa Economic Review 2 (1986): 94-98.

Ensminger, J. "Economic and Political Differentiation among Galole Orma women." Ethos 52 (1987): 28-49.

Elabor-Idemudia, P. "The Impact of Structural Adjustment Programs on Women and Their Households in Bendel and Ogun States, Nigeria," in C. Gladwin, ed. Structural Adjustment and African Women Farmers, p. 128-150. Gainesville, FL: University of Florida Press, 1991.

Eicher, C.K. "Facing Up to Africa's Food Crisis." Foreign Affairs 61 (1982):151—174.

Eicher, C.K. "Zimbabwe's Maize-Based Green Revolution: Preconditions for Replication. World Development 23 (1995): 805—818.

Food and Agriculture Organization (FAO). Statistics. FAO: www.fao.org/stats/, 1998.

Glehouenou, B., and M. Galiba. *Les Caisses Rurales d'Epargne et de Pret of Benin*," in S.A. Breth, ed. Microfinance in Africa. Mexico City: Sasakawa Africa Association, 1999.

Giller, K.E., J.F. McDonagh, and G. Cadisch. "Can Biological Nitrogen Fixation Sustain Agriculture in the Tropics?" in J.K. Syers and D.L. Rimmer, eds. Soil Science and Sustainable Land Management in the Tropics, p. 173–-191. Wallingford, UK: CAB International, 1994.

Gladwin, C.H. "A View of the Plan Puebla: An Application of Hierarchical Decision Models." American Journal of Agricultural Economics, 58 (1976): pp. 881-887.

Gladwin, C.H. “Fertilizer Subsidy Removal Programs and Their Potential Impacts on Women Farmers in Malawi and Cameroon,” In: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers. Gainesville, FL: University of Florida Press, pp. 191-216, 1991.

Gladwin, C.H. “Gendered Impacts of Fertilizer Subsidy Removal Programs in Malawi and Cameroon.” Agricultural Economics 7 (1992): 141-153.

Gladwin, C.H. “Gender in Research Design: Old Debates and New Issues,” in: S. Breth, ed. Achieving Greater Impact from Research Investments in Africa, pp. 127-149. Mexico City, Mexico: Sasakawa Africa Association, 1996.

Gladwin, C.H. “Targeting Women Farmers to Increase Food Production in Africa,” in: S. Breth, ed. Women, Agricultural Intensification, and Household Food Security, pp. 55-71. Mexico City, Mexico: Sasakawa Africa Association, 1997.

Gladwin , C.H., McMillan, D. “Is a Turnaround in Africa Possible without Helping African Women to Farm?” Economic Development and Cultural Change 37 (1989): 345-369.

Gladwin, C.H., Thomson, A.M., Peterson, J.S., Anderson, A.S. “Addressing Food Security in Africa via Multiple Livelihood Strategies of Women Farmers.” Food Policy 26 (2001): 177-207.

Goheen, M. “The Ideology and Political Economy of Gender: Women and Land in Nso, Cameroon,” in: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers. Gainesville, FL: University of Florida Press, pp. 239- 256.

Goheen, M. Men Own the Fields, Women Own the Crops. Madison, WI: University of Wisconsin Press, 1996.

Goldman, A., and J. Smith. “Agricultural Transformations in India and Northern Nigeria: Exploring the Nature of Green Revolutions.” World Development 23 (1995): 243–-263.

Gordon, A.A. Transforming Capitalism and Patriarchy: Gender and Development in Africa. Boulder, CO: Lynne Rienner Publishers, 1996.

Gough, A.E. The Starter Pack Program in Malawi: Implications for Household Food Security. MS Thesis, University of Florida, 2002.

Harris, G.T. “Fertilizer Subsidies in Developing Countries.” Muscle Shoals, AL: International Fertilizer Development Center, 1984.

Henderson, C. Asia Falling. New York: McGraw-Hill, 1998.

Hill, P. The Migrant Cocoa-Farmers of Southern Ghana. Cambridge: Cambridge University Press, 1963.

Kaberry, P.M. Women of the Grassfields. London: H.M. Royal Stationery Office, 1952.

Khandker, S.R., B. Khalily, and Z. Khan. "Grameen Bank: Performance and Sustainability. Washington, DC: The World Bank, 1995.

Kumwenda, J.D.T., Waddington, S.R., Snapp, S. S., Jones, R.B., Blackie, M.J. "Soil Fertility Management Research for the Maize Cropping Systems of Smallholders in Southern Africa: A Review. Natural Resources Group Paper 96-2. Mexico City, Mexico: Centro Internacional para la Mejoramiento de Maiz Y Trigo, 1996.

Larson, B.A., Frisvold, G.B. "Fertilizers to Support Agricultural Development in Sub-Saharan Africa: What is Needed and Why." Food Policy 21 (1996): 509—525.

Lele, U., Christiansen, R.E., Kadiresan, K. "Fertilizer Policy in Africa: Lessons from Development Programs and Adjustment Lending, 1970-87." Managing Agricultural Development in Africa discussion paper 5. Washington, D.C.: World Bank, 1989.

Lele, U. "Structural Adjustment, Agricultural Development and the Poor: Some Lessons from the Malawian Experience. World Development 18 (1990): 1207-1219.

Longley, C., Coulter, J., Thompson, R. "Malawi Rural Livelihoods Starter Pack Scheme, 1998-99: Evaluation Report." London: Overseas Development Institute, 1999.

Mann, C. "Higher Yields for All Smallholders; the Surest Way to Restart Economic Growth in Malawi." Cambridge, MA: Harvard Institute for International Development, 1998.

Meena, R. "The Impact of Structural Adjustment Programs on Rural Women in Tanzania," In: C.H. Gladwin, ed. Structural Adjustment and African Women Farmers, pp. 169-190. University of Florida Press, 1991.

Mehra, R. "Can Structural Adjustment Work for Women Farmers?" American Journal of Agricultural Economics 73, no. 5 (1991): 1440-7.

Moock, J. L. Understanding Africa's Rural Households and Farming Systems. Boulder, CO: Westview Press,1986.

Olayiwole, Comfort B. "The Role of Home Economics Agents in Rural Development Programs in Northern Nigeria: Impacts of Structural Adjustment." In: C.H. Gladwin, ed. Structural Adjustment and African Women Farmers, pp. 359-372. University of Florida Press, 1991.

Quisumbing, Agnes R. "Male-Female Differences in Agricultural Productivity: Methodological Issues and Empirical Evidence." Economic Development and Cultural Change 24(1996): 1579-96.

Saito, K., H. Mekonnen, and D. Spurling. "Raising the Productivity of Women Farmers in Sub-Saharan Africa." Discussion Paper 230. Washington, DC: The World Bank, 1994.

Palm, C.A., Myers, R.J.K., and Nandwa, S.M. "Combined Use of Organic and Inorganic Nutrient Sources for Soil Fertility Maintenance and Replenishment," in: Sanchez, P., and Buresh, R., eds. Replenishing Soil Fertility in Africa. Madison, WI: Soil Science Society of America Special Publication no. 51, pp. 193-217, 1997.

Parpart, J.L., and K.A. Staudt. Women and the State in Africa. Boulder, CO: Lynne Rienner Publishers,1989.

Pinstrup-Andersen, P. "Fertilizer Subsidies: Balancing Short-Term Responses with Long-Term Imperatives," in N. Russell and C. Dowswell, eds. Policy Options for Agricultural Development in sub-Saharan Africa. Airlie House, VA: Center for Applied Studies in International Negotiations (CASIN)/ Sasakawa Global 2000, 1992.

Rocheleau, D. "Women, Men, and Trees: Gender, Power, and Property in Forest and Agrarian Landscapes." Paper prepared for GENDER-PROP, An International E-mail Conference on Gender and Property Rights, 1995.

Sachs, J. "The Limits of Convergence." The Economist, June 14, 1997: 19-22.

Sacks, K. Sisters and Wives: the Past and Future of Sexual Equality. Chicago: University of Illinois Press, 1982.

Sanchez, P., Izac, A.M., Buresh, R., Shepherd, K., Soule, M., Mokwunye, U., Palm, C., Woomer, P., Nderitu, C. "Soil Fertility Replenishment in Africa as an Investment in Natural Resource Capital." In: Buresh, R., Sanchez, P. (eds.) Replenishing Soil Fertility in Africa, SSSA Special Publication 51. Madison, WI: Soil Science Society of America (SSSA), 1997.

Smale, M. "Maize is Life: Malawi's Delayed Green Revolution." World Development 23 (1995): 819-831.

Smaling, E.M., Nandwa, S.M., Janssen, B.H. "Soil Fertility in Africa is at Stake." In: Sanchez, P., and Buresh, R. (eds.), Replenishing Soil Fertility in Africa. Madison, WI: Soil Science Society of America Special Publication no. 51, pp. 47-62, 1997.

Snapp, S. "Mother and Baby Trials: A Novel Trial Design Being Tried Out in Malawi." Target (January, 1999) 17: 8.

Staudt, K. "Women Farmers and Inequities in Agricultural Services." Rural Africana 29: 81-93, 1975.

Thomas-Slayter, B., and D. Rocheleau. Gender, Environment, and Development in Kenya: A Grassroots Perspective. Boulder, CO.: Lynne Rienner Publishers, 1995.

Timmer, C.P., W.P. Falcon, and S. Pearson. Food Policy Analysis. Baltimore, MD: Johns Hopkins Press, 1983.

Udry, Christopher. "Gender, Agricultural Production, and the Theory of the Household." Journal of Political Economy 104 (1996): 1010-1046.

Uttaro, R.P. "Diminishing Returns: Soil Fertility, Fertilizer, and the Strategies of Farmers in Zomba RDP in Southern Malawi. Gainesville, FL: Report to the University of Florida Soils Collaborative Research Support Project, 1998.

Tomich, T.P., Kilby, P., Johnston, B.F. Transforming Agrarian Economies. Ithaca, NY: Cornell University Press, 1995.

Tsoka, M., and P. Mvula. "Malawi Coping Strategies Survey." Zomba, Malawi: Centre for Social Research, 1999.

Van der Eng, P. "Development of Seed-Fertilizer Technology in Indonesian Rice Agriculture." Agricultural History 68 (1994): 20-–53.

Von Pischke, J.D. Finance at the Frontier. Washington, DC: The World Bank, 1991.

World Bank. Structural Adjustment in Africa. New York: Oxford University Press, 1994.

Wortmann, C.S., and D.J. Allen. "African Bean Production Environments: Their Definition, Characteristics, and Constraints." Center for Tropical Agriculture (CIAT): Network on Bean Research in Africa, Occasional Publications Series No. 11, 1994.

Yaron, J. "Assessing Development Finance Institutions: A Public Interest Analysis." World Bank Discussion Paper 174. The World Bank, Washington, D.C, 1992.

Yaron, J. "Performance of Development Finance Institutions: How to Assess It?" Paper presented to the Organization for Economic Cooperation and Development (OECD), Paris, France: OECD, 1996.

Reference Style: The following is the suggested format for referencing this article: Gladwin, Christina. "Gender and Soil Fertility in Africa: An Introduction." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a1.htm

Gender and Soil Fertility in Uganda: A Comparison of Soil Fertility Indicators for Women and Men's Agricultural Plots

PETER NKEDI-KIZZA, JACOB ANIKU, KAFUI AWUMA, AND CHRISTINA H. GLADWIN

Abstract: The removal of subsidy under the structural adjustment programs of the World Bank has increased the cost of fertilizers and lowered the level of fertilizer input use among the small-scale farmers in Uganda and in many African countries. It is also reported that female farmers lack cash or credit to finance agricultural inputs, as such they apply less fertilizers to their crops than male farmers. In addition there is a perception that female farmers in Africa are allocated less fertile land by their spouses. We conducted this research to determine whether the gender difference in wealth and land allocation between male and female farmers in male-headed households is manifested in soil fertility indicators. We determined chemical fertility levels (fertility indicators) in the composite topsoil samples from 5 woman-owned plots and 5 man-owned plots in Ntanzi village, Uganda, on a Rhodic Ferralsol. A similar study was conducted on 8 woman-owned and 8 man-owned plots in Buggala Island, Uganda, on a Ferralic Arenosol. In total we took topsoil samples from 13 male-headed households, and sampled by horizon 13 soil profiles. No female-headed households (FHHs) were included in this study. Therefore when we use the words "women" or "female" we are referring to married women/females in male-headed households. The FHHs were omitted from this study because they had no consistent comparable "male match" with agricultural plots from which we could take soil samples.

The study showed no statistical significant difference between soil fertility indicators of plots owned by wives vs husbands. The soil data from wives' and husbands' plots had low soil fertility levels of most soil fertility indicators, implying that they had been under comparable poor management practices. On-farm demonstrations of soil nutrient management options are recommended to convince both women and men farmers about the benefits of improved soil fertility technologies.

Introduction

Uganda is blessed with a wide diversity of natural resources: soil, climate, water and vegetation, enabling it to grow a large number of adapted crops. However, most soils in Uganda are older than 500 millions years and are in their final stage of weathering. The predominant minerals in the soils are quartz and kaolinite that don't directly supply nutrients to soils. The soils are acidic and infertile with low cation exchange capacity (CEC). Nutrients

Peter Nkedi-Kizza is at the Soil and Water Science Department, University of Florida, Gainesville, Florida. **Jacob Aniku** is at the Soil Science Department, Makerere University, Kampala, Uganda. **Christina H. Gladwin** is with the Food and Resource Economics, Department, University of Florida, Gainesville, Florida.

http://www.africa.ufl.edu/asq/v6/v6i1-2a2.pdf

ISSN: 2152-2448

such as phosphorus occur in inorganic and organic forms that are not readily available to crops. Phosphorus is fixed by oxides of iron and aluminum. Nitrogen that is low in most mineral soils can only be naturally supplied to the soil from the atmosphere by symbiotic biological fixation and slowly from organic matter. Potassium another essential element, is also limiting in these soils because there are no primary minerals that can supply it. Also, due to the low CEC, inorganic cations are easily leached out of the root-zone of most crops.[1]

The total land area of Uganda is 241,000 square kilometers (km2) of which more than 25% is unproductive. These agriculturally unproductive areas include swamps, mountains, national parks, urban centers and open water. Arable land comprises 75% of the total land area, but only 10% can be considered as agriculturally productive land. The remaining land surface is rated as moderate, implying the sort of soils that will support crops under good management.

The land area under cultivation is about 4.6 million hectares (ha), with 4.3 million ha cultivated to food crops, while cash crops cover about 0.3 million ha. The agricultural output comes almost exclusively from about 2.5 million smallholders, 80% of whom have less than 2 ha each. Only tea and sugar cane are grown on large estates that total about 50,000 ha. Both food and cash crops are almost entirely rainfed. The smallholder farms in the rural areas are owned and managed by both women and men farmers.[2]

Over the years, food production has been characterized by subsistence farming. A subsistence production system usually focuses on a maximizing short-term profit, consuming natural stocks of plant nutrients. Such a farming system has resulted in soil fertility degradation through nutrient mining. In the past, when Uganda's population was still low, lost soil fertility was restored through long periods of fallows. With an average land holding of about 2 ha per household, fallows are no longer practical or the periods greatly shortened. Research has clearly demonstrated that fertilizer inputs and appropriate land management practices are important components of technology required to increase crop yields in Uganda.[3]

The removal of fertilizer subsidies under the privatization program in Uganda, in 1992, has greatly increased the production cost for farmers without corresponding increases in producer prices. As a result, fertilizers, more often than not, can only be afforded by the better-off farm households who have access to cash and credit facilities.

Studies conducted in Malawi and Cameroon by Gladwin (1991, 1992) showed that the average female-headed farm household used significantly less fertilizer per hectare than the male-headed farm household. The studies attributed lower fertilizer use by women to the fact that they have less access to cash and credit. [4] However, it is not clear whether these gender differences in soil fertility management would also be reflected in soil fertility indicators measured from fields or farms of women and men who are spouses.

The main objective of this research was to evaluate and compare the soil nutrient levels and other soil fertility indicators from a wife's and a husband's agricultural plots at a male-headed household in the rural areas of Uganda.

MATERIALS AND METHODS

Research Site and field methods

The study was conducted in two agro-ecological zones in Uganda. One study site was located in Ntanzi village in the Lake Victoria Crescent agro-ecological zone. Ntanzi village is located on latitude 0 15' N and Longitude 32 50' E. It has an udic and isohyperthermic soil climate. The soils developed in a sedentary parent material derived from the underlying acid gneisses and granites. The village has a high population density, estimated at 145 people per km2. The soils are intensively cultivated to both food and cash crops. The main food crops include maize, beans, peanuts, sweet potatoes, bananas and cassava. Robusta coffee is the major cash crop. The farmers keep a small number of livestock on their land.

The other agro-ecological zone is Buggala Island where two study sites; Kagulube and Kanyogoga villages are located. Kagulube and Kanyogoga lie on latitude 0 10' S and longitude 32 0' E, and latitude 0 10' S and longitude 32 15' E, respectively. The soils in both locations developed on weathered sandstones. Both villages have very low population densities, estimated at less than 30 people per km2 each. Shifting cultivation is still practiced here. The main crops are generally root crops, such as sweet potatoes and cassava. Bananas and coffee perform poorly. The Buggala Island has an udic and isohyperthermic soil climate. A small number of livestock, especially goats, are kept on the land holdings.

A scouting trip was made to each of the study sites to carry out a situation analysis. The visiting time was also used to make preliminary contacts with authorities and to identify appropriate groups of farmers for discussion, interviews and participation in the project. The field scouting trips were also used to observe landforms, soils, vegetation, cropping patterns, and stages of crop growth in the selected villages. Five married couples (husband and wife) were selected from Ntanzi village for the study, while Kagulube and Kanyogoga villages had 4 couples each, as participating farmers.

A plot of land measuring 50 m x 50 m was selected on the farm of each participating farmer for the purpose of obtaining composite topsoil samples. Five transect lines, running across the slope of the plot, were drawn at 10 m intervals. Along each transect, topsoil samples, 20 cm deep, were taken with a bucket augur (7.6 cm diameter) at 10 m intervals. The five samples obtained from each transect were thoroughly mixed and a representative composite soil sample of one kg was obtained. Five composite topsoil samples were thus obtained for each participating farmer.

Soil pits were located in each village (at each male headed household), based upon discernible changes in topography, vegetation, land use and other indications seen on the ground and from aerial photographs of the villages. The location of the soil pit was selected to ensure that each farmer's sampled plot was truly represented. The soils from 13 profiles were described and sampled by horizon. They were classified based on three systems of classification FAO-UNESCO, USDA, and the local system.[5]

LABORATORY METHODS

The soil samples were air-dried, ground to pass through a 2-mm sieve and stored in glass bottles. Soil pH was measured in soil-distilled water suspensions (1:2) with a pH meter. Mechanical analysis was performed as described by Bouyoucos (1962). Exchangeable cations were determined after leaching soils with I M ammonium acetate. Exchangeable K and Na were analyzed by flame photometry, exchangeable Ca and Mg by atomic absorption spectrometry (Perkin-Elmer, Model 2280). Total exchangeable bases were calculated from the sum of exchangeable K, Na, Ca and Mg. Available P was determined by the method of Olsen et al (1954). Total N was determined by the Kjeldahl method (Bremner 1965). Organic carbon content (OC) was measured by the Walkley-Black method (Allison 1965) and soil organic matter (SOM) was calculated by multiplying OC content by a factor of 1.724.

RESULTS AND DISCUSSION

The soil data for Ntanzi village are presented in Tables 1A, IB, and 2. A representative pedon description and soil characterization based on the laboratory soil analysis are presented in Tables 1A and 1B, respectively. The Ntanzi soil was classified as Rhodic Ferralsols according to FAO-UNESCO (1988). The USDA classification and the local classification of the soil are also included in Table 1B. The taxonomical classification indicate that the soil is highly weathered, and devoid of weatherable minerals. The values of the total bases decrease with soil depth but tend to increase at the 170 cm soil depth indicating leaching of bases from upper horizons. The textural class changes from loam for the topsoil to clay loam for the subsoil implying leaching of clay from upper horizons. Based on recommendations in Table 3, the soil is deficient in SOM at all depths. The soil has low total N, pH, available P, K, and Ca at almost all soil depths. For all parameters listed in Table 2, there was no statistically significant difference in fertility indicator values between data obtained from female and male agricultural plots. However, all soils have low to deficient soil fertility indicator values when compared to data in Table 3. All topsoil samples have a sandy clay loam texture and are acidic. The low nutrient levels in all soil samples imply that the management practices on women and men's agricultural plots have been similar. The low to deficient values of available macro-nutrients (N, P, K, and Ca) suggest that the application of fertilizers should be of benefit to most crops in this village.

Table 1A. Description of a Selected Pedon from Ntanzi Village
Profile: Pit-PN1-Ntanzi

Location:	On Christine Nambi's plot of land in Ntanzi village, Mukono District. The pit is about 50m south of Mrs. Nambi's house and about 30m from the lower boundary of the plot.
Vegetation:	The land is planted to bananas mixed with coffee.
Parent Material:	Sedentary material derived from weathered granites and Gneisses.
Geomorphology:	The profile is located in the middle of a long gentle slope.
Drainage:	Well drained.
Moisture :	Upper 20 cm dry, moist below
Rock out crops:	None
Erosion:	No evidence

Diagnostic characteristics:

FAO-UNESCO:	Oxic B horizon
USDA:	Oxic horizon

Profile Description:

Soil depth (cm)	Horizon description
0 - 3	Un-decomposed and partly decomposed organic materials
3 - 20	Dark reddish brown 5YR ¾ moist, loam; strong, coarse angular blocky; hard, slightly sticky, slightly plastic; many coarse and fine roots, many coarse and medium pores; clear boundary to next horizon (sample number 43).
20 - 34	Dark red 2.5 YR 3/6 moist, clay loam, strong angular blocky; firm, slightly sticky, slightly plastic, few fine roots; many termite channels, many fine pores; clear boundary to next horizon (sample number 46)
34 - 56	Dusky red 10 YR ¾ moist, clay loam; strong angular blocky; firm slightly sticky, slightly plastic; few fine roots; many termite and earth worm channels, many fine pores; diffuse lower boundary (sample number 65).
56 - 85	Weak red 10 YR 4/4 moist, clay; strong angular blocky; firm, sticky, plastic; few fine roots; many termite and earthworm channels; many fine and medium pores; diffuse lower boundary (sample number 48).
85 - 115	Dark red 10 R 3/6 moist, clay loam; strong, angular blocky, friable, sticky, plastic, few fine roots; many fine pores; few channels (sample number 51).
115 - 170+	Weak red 10 R 4/4 moist, clay loam; strong angular blocky; friable, sticky, plastic; many fine roots (sample number 55)

Table 1B. Soil Characterization Laboratory, Makerere University,
Kampala, Uganda
Profile: Pit-PN1-Ntanzi

Classification:
FAO-UNESCO: Rhodic Ferralsols, fine textured (5)
USDA: Rhodic Kandiudoxs, clayey, isohyperthemic (10)
LOCAL: Buganda Loam series: a member of Buganda Catena soil association; Lateritic soil (11)

Values of laboratory data for soil samples from Pit-PN1-Ntanzi village

Fertility indicator (Soil parameter)	Depth (cm) 3 - 20	Depth (cm) 20 - 34	Depth (cm) 34 - 56	Depth (cm) 56 - 85	Depth (cm) 85 - 115	Depth (cm) 115 - 170+
Lab NO	43	46	65	48	91	55
pH (H_2O)	4.7	5.0	4.7	5.0	5.0	5.2
SOM (g/kg)	28.9	4.7	5.2	2.5	2.6	2.6
Total N (g/kg)	1.90	0.90	1.00	0.90	1.00	0.70
Available P (mg/kg)	16.80	5.60	14.00	5.60	2.80	28.00
NH_4OAC Extractable Ca (cmol/kg)	3.66	2.76	2.70	2.66	0.72	3.26
NH_4OAC Extractable Mg (cmol/kg)	0.85	1.22	1.04	0.84	0.38	1.40
NH_4OAC Extractable K (cmol/kg)	0.18	0.10	0.17	0.10	0.14	0.17
NH_4OAC Extractable Na (cmol/kg)	0.26	0.02	0.05	0.02	0.05	0.08
Total bases (cmol/kg)	4.95	4.10	3.96	3.62	1.29	4.91
Sand %	46	33	29	33	41	37
Clay %	23	36	39	41	37	33
Silt %	31	31	32	26	22	30
Textural class	Loam	Clay Loam	Clay Loam	Clay	Clay Loam	Clay Loam

Table 2. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Ntanzi village

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	5.46 ± 0.12	5.64 ± 0.13
SOM (g/kg)	34.10 ± 5.60	34.60 ± 2.30
Total N (g/kg)	2.20 ± 0.20	2.60 ± 0.20
Available P (mg/kg)	5.89 ± 2.58	6.79 ± 2.57
NH_4OAC Extractable Ca (cmol/kg)	7.12 ± 0.57	7.99 ± 0.71
NH_4OAC Extractable Mg (cmol/kg)	2.24 ± 0.19	2.54 ± 0.30
NH_4OAC Extractable K (cmol/kg)	0.46 ± 0.10	0.71 ± 0.14
NH_4OAC Extractable Na (cmol/kg)	0.37 ± 0.14	0.26 ± 0.06
Total bases (cmol/kg)	10.19 ± 0.25	11.50 ± 0.30
Sand %	47 ± 2	49 ± 3
Clay %	29 ± 2	26 ± 2
Silt %	24 ± 2	25 ± 3
Textural class	Sandy clay loam	Sandy clay loam

N = 25; SOM = Soil organic matter; ± 95% confidence interval

Table 3. Soil Standards and Rating for Crop Production in Uganda (13)

Soil property/parameter	Deficient level	Low level	High level
pH (2.5:1 water)	4.5	5.2	6.2
SOM (g/kg)	17.2	30	60
Total N (g/kg)	1	NA	NA
Available P (mg/kg) Bray 1	5	5	20
Exchangeable K (cmol/kg)	0.2	0.4	1.3
Exchangeable Ca (cmol/kg)	2	2	10
Exchangeable Mg (cmol/kg)	0.5	NA	NA

NA = Not available; Deficient level implies can not support crop growth

Immediately after the soil samples were taken from Ntanzi village, 69 farmers were invited for a one-day seminar to discuss the issue of gender and soil fertility. Out of the 69 farmers, 20 were women. A simple survey was carried out. The participating farmers were asked if they thought that there was a gender bias in soil fertility in their village, in the sense that husbands allocated to their wives agricultural plots that were inferior in soil fertility. 68% of the women felt that there was no gender bias vs. 48% of the men. The survey revealed that gender in soil fertility was not considered an issue in Ntanzi village, supporting actual soil laboratory data discussed earlier.

The soil data from Kagulube village are shown in Tables 4A, 4B, and 5. The profile was classified as Ferralic Arenosols, according to FAO-UNESCO (5). The USDA and the local classifications are also indicated in Table 4B. Under the high rainfall and aided by the coarse texture of the parent material, the soil from Kagulube village has been thoroughly leached of bases. The increase in base concentration at the 120 cm depth is an indication of leaching of bases from upper horizons. A similar trend is also observed for the increase in clay content to a depth of 120 cm. Data presented in Table 4B, clearly show that the soil is highly acidic and deficient in SOM, total N, exchangeable Ca, Mg, and K. With the exception of available P, the topsoil from all agricultural plots is chemically poor (compare Tables 3 and 5). The low nutrient values in wives' and husbands' plots suggest that they have been under comparable management practices. As was observed for Ntanzi village, there was no significant difference in soil fertility indicator values between soil samples taken from wives' and husbands' agricultural plots at Kagulube village (Table 5).

Table 4A. Description of a Selected Pedon from Kagulube Village,
Kalangala District, Ssese Islands
Profile: Pit-PK2-Kagulube

Location:	On Mr. Simeo Gyagenda's plot of land in Kagulube village, Kalangala District. The pit is about 30 m east of Gyagenda's residence..
Vegetation:	Underground nuts, cassava, sweet potatoes and corn.
Parent Material:	Sedentary material derived from coarse texture acid rocks
Geomorphology:	The profile is located on a crest of a broad ridge.
Elevation:	1170 m
Drainage:	Well drained.
Moisture:	Moist throughout
Rock out crops:	None
Erosion:	No evidence

Diagnostic characteristics
A profile of a thin brown ochric A-horizon over a deep subsoil which shows the beginning of horizon differentiation that is taxonomically insignificant.

Profile Description:

Soil depth (cm)	Horizon description
0 - 20	Dark brown 7.5 YR 3/3 moist, sandy loam; weak crumbs to loose, many coarse and fine roots; many channels and medium pores; clear smooth boundary (sample number7) .
20 - 33	Dark brown 7.5 YR 4/3 moist, sandy loam; weak crumbs to loose, many coarse and fine roots; many channels and medium pores; some pieces of charcoal; gradual smooth boundary (sample number 35)
33 - 70	Reddish brown 5 YR 4/4 moist, sandy clay loam; weak coarse angular blocky; friable, slightly sticky, slightly plastic; few coarse roots, few fine roots; many channels and fine to medium pores; diffuse boundary (sample number 40)
70 - 120	Reddish brown 5 YR 5/4 moist, sandy clay; strong coarse sub-angular blocky, firm, sticky, plastic; few coarse roots, few fine roots; many channels and fine pores; diffuse boundary (sample number 62)
120 - 140+	Reddish brown 5 YR 5/4 moist, sandy loam; weak coarse sub-angular blocky; friable, slightly sticky, slightly plastic; few fine roots, many fine and medium pores (sample number 29).

Table 4B: Soil Characterization Laboratory, Makerere University
Kampala, Uganda
Profile: Pit-PK2-Kagulube

Classification:
FAO-UNESCO: Ferralic Arenosols (5)
USDA: Typic Kandhapludults; fine –loamy, Siliceous, isothermic (10)
LOCAL: Bugoma series: (11)

Values of laboratory data for soil samples from Pit-PK2-Kagulube village

Fertility indicator (Soil parameter)	Depth (cm) 0 - 20	Depth (cm) 20 - 33	Depth (cm) 33 - 70	Depth (cm) 70 - 120	Depth (cm) 120 -140+
Lab NO	7	35	40	62	29
pH (H_2O)	4.6	4.8	4.6	5.0	5.3
SOM (g/kg)	18.0	14.0	10.5	6.0	26.5
Total N (g/kg)	1.20	0.70	0.90	0.70	1.70
Available P (mg/kg)	66.0	56.0	77.0	344.4	61.6
NH_4OAC Extractable Ca (cmol/kg)	0.95	0.60	0.71	0.96	3.60
NH_4OAC Extractable Mg (cmol/kg)	0.36	0.20	0.37	1.02	1.29
NH_4OAC Extractable K (cmol/kg)	0.18	0.14	0.17	0.17	0.55
NH_4OAC Extractable Na (cmol/kg)	0.30	0.05	0.05	0.08	0.29
Total bases (cmol/kg)	1.79	0.99	1.30	2.23	5.73
Sand %	74	70	53	49	65
Clay %	11	17	34	39	19
Silt %	15	13	13	12	16
Textural class	Sandy loam	Sandy loam	Sandy clay loam	Sandy clay	Sandy loam

Table 5. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Kagulube village, Kalangala District, Ssese Islands

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	5.43 ± 0.19	5.25 ± 0.23
SOM (g/kg)	15.10 ± 3.10	15.10 ± 3.50
Total N (g/kg)	1.40 ± 0.20	1.40 ± 0.20
Available P (mg/kg)	202.73 ± 66.91	133.24 ± 53.08
NH_4OAC Extractable Ca (cmol/kg)	5.02 ± 1.39	2.97 ± 0.71
NH_4OAC Extractable Mg (cmol/kg)	1.28 ± 0.32	0.92 ± 0.21
NH_4OAC Extractable K (cmol/kg)	0.64 ± 0.18	0.53 ± 0.10
NH_4OAC Extractable Na (cmol/kg)	0.24 ± 0.06	0.24 ± 0.05
Total bases (cmol/kg)	7.18 ± 0.49	4.66 ± 0.27
Sand %	72 ± 2	69 ± 5
Clay %	11 ± 1	14 ± 2
Silt %	17 ± 2	17 ± 3
Textural class	Sandy loam	Sandy loam

N = 20; SOM = Soil organic matter; $\pm$ 95% confidence interval

The data for Kanyogoga village are shown in Tables 6A, 6B and 7. Like soils of Kagulube village, the Kanyogoga soils are classified as Ferralic Arenosols. The soil from the pedon is deficient in total N, and exchangeable bases (compare Tables 3 and 6B). The soil has extremely high amounts of available P as was observed for the soil from Kagulube village. The leaching of bases and clay from upper horizons to lower horizons is also evident (Table 6B). As was observed for Ntanzi and Kagulube villages, there was no significant difference in values of soil fertility indicators between soil samples taken from female and male agricultural plots (Table 7). Similarities between data obtained from woman- and man- owned agricultural plots are an indication that the plots have been under similar farming systems and management practices.

Table 6A. Description of a Selected Pedon from Kanyogoga Village, Kalangala District, Ssese Islands

Profile: Pit-PKG1-Kanyogoga

Location:	About 1 km east of Kalangala town in Kanyogoga village
Vegetation:	Mature cassava
Parent Material:	Colluvium and possibly lake alluvium
Geomorphology:	The profile is located in the middle of a long gentle slope
Elevation:	1150 m
Drainage:	Well drained.
Moisture:	Moist throughout
Rock out crops:	None within the pit but many located 100 m from the pit
Erosion:	No evidence

Profile Description:

Soil depth (cm)	Horizon description
0 - 46	Dark reddish brown 5 YR 3/2 moist, sandy loam; weak crumb; friable, non-sticky, non-plastic, many coarse and fine roots; many termite channels, many fine and medium pores, clear, smooth boundary (sample number 83)
46 - 60	Reddish brown 5 YR 4/4 moist, sandy loam; weak crumb; friable non-sticky, non-plastic; few coarse roots; many termite channels, many medium and fine pores; clear smooth boundary (sample number 3)
60 - 76	Yellowish red 5 YR 5/6 moist, sandy clay loam; weak coarse sub-angular blocky; friable, few coarse and many fine roots; many termite channels, many medium and fine pores; abrupt boundary to sandstone layer (sample number 17).

Table 6B: Soil Characterization Laboratory, Makerere University
Kampala, Uganda
Profile: Pit-PKG1-Kanyogoga

Classification:
FAO-UNESCO: Ferralic Arenosols (5)
USDA: Typic Kandhapludults; fine-loamy, Siliceous, isothermic (10)
LOCAL: Kikwayu series: (11)

Values of laboratory data for soil samples from Pit-PKG1-Kanyogoga village

Fertility indicator (Soil parameter)	Depth (cm) 0 - 46	Depth (cm) 46 - 60	Depth (cm) 60 - 76
Lab NO	83	3	17
pH (H_2O)	4.8	4.9	5.1
SOM (g/kg)	31.0	25.0	23.0
Total N (g/kg)	2.40	1.50	1.70
Available P (mg/kg)	93.80	260.0	180.0
NH_4OAC Extractable Ca (cmol/kg)	1.80	1.03	1.14
NH_4OAC Extractable Mg (cmol/kg)	0.26	0.29	0.30
NH_4OAC Extractable K (cmol/kg)	0.21	0.17	0.14
NH_4OAC Extractable Na (cmol/kg)	0.08	0.13	0.05
Total bases (cmol/kg)	2.35	1.62	1.63
Sand %	74	70	53
Clay %	11	17	34
Silt %	15	13	13
Textural class	Sandy loam	Sandy loam	Sandy clay loam

Table 7. Mean values of laboratory data for composite topsoil samples from female and male owned agricultural plots from Kanyogoga village, Ssese Islands

Fertility indicator (Soil parameter)	All Wives	All Husbands
pH (H_2O)	4.49 ± 0.20	4.16 ± 0.23
SOM (g/kg)	32.40 ± 4.40	39.80 ± 5.40
Total N (g/kg)	2.60 ± 0.20	3.40 ± 0.30
Available P (mg/kg)	144.48 ± 31.73	130.08 ± 25.64
NH_4OAC Extractable Ca (cmol/kg)	1.25 ± 0.40	1.50 ± 0.62
NH_4OAC Extractable Mg (cmol/kg)	0.39 ± 0.11	0.45 ± 0.15
NH_4OAC Extractable K (cmol/kg)	0.52 ± 0.12	0.33 ± 0.17
NH_4OAC Extractable Na (cmol/kg)	0.24 ± 0.07	0.23 ± 0.07
Total bases (cmol/kg)	2.40 ± 0.18	2.51 ± 0.25
Sand %	69 ± 6	69 ± 7
Clay %	6 ± 1	6 ± 1
Silt %	25 ± 5	25 ± 7
Textural class	Sandy loam	Sandy loam

N = 20; SOM = Soil organic matter; ± 95% confidence interval

The fertilizer recommendations for the banana-based cropping system in Uganda are 100 kg N and 100 kg K ha-1 yr-1, respectively. The recommended input rates for coffee are 100kg N ha-1 yr-1 and mulching. These soil management recommendations are rarely practiced neither by women nor men farmers. The cost of fertilizers is too high, and in some rural locations, fertilizers are not readily available (2).

Interviews with some household farmers by Aniku et al., (2001) revealed that most farmers are aware of the decline in soil fertility. These farmers would like to increase the productivity of their soils, but they are afraid to use fertilizers because they have been told that fertilizers destroy soil productivity. Including N-fixing legumes in crop rotations can increase soil fertility, but farmers would not include soybean in their cropping rotations because they believe soybean exhausts soil fertility. Most farmers in Ntazi, Kagulube, and Kanyogoga villages have had some elementary schooling. They would therefore be willing to adopt improved land management methods when the benefits can be clearly demonstrated to them.

Conclusions

Gladwin et al., (1997) have proposed a toolbox of solutions to overcome constraints faced by female farmers when trying to improve the productivity of their farmlands. The suggested solutions include: fertilizer vouchers, small bags of fertilizers sold in local shops and markets, microcredit for fertilizers, grants or free bags of fertilizers, as well as organic-source option and techniques such as nitrogen-fixing agroforestry innovations and rotations of legumes. Because the farmers need to be convinced on the benefits of fertilizer inputs, there is a need to demonstrate these benefits in on-farm experiments.

The solutions suggested by Gladwin et al. (1997), are targeted towards assisting women farmers to improve their land management practices.[6] This study has shown that for male-headed households, there is no difference in soil fertility indicators measured in agricultural plots owned by husbands or wives. This implies that husbands do not allocate soils of inferior fertility to their wives to farm. If there are lowered yields and less productivity on women's fields, therefore, the differences might be due to other (socioeconomic) factors, such as women's lack of cash or credit for fertilizers, and women's lack of extension information about new soil-fertility technologies.

Vosti and Readon (1995) have suggested that the adoption of land management technologies need to be widespread. They pointed out that "unsustainable practices on non-adopting farms could harm neighbors and degrade the shared resource base". [7] We are suggesting that in Uganda the solutions proposed by Gladwin et al. be reconsidered to target both poor women and men farmers.

In this study we found no significant difference in soil fertility indicators between men- and weman-owned agricultural plots. This should not be surprising because soil-forming factors (such as parent material, climate, vegetation, topography, and time) have nothing to do with gender issues. However, this study clearly shows that the soils in the two regions of Uganda are deficient (have low levels) on most soil fertility indicators. In addition, both male and female farmers are not convinced of the benefits of fertilizers as agricultural inputs. On-farm demonstrations on the various soil management technologies are recommended to convince both men and women farmers of the benefits of the technologies.

Notes

1. Harrop 1970, 43.
2. Aniku , Kataama, Nkedi-Kizza and Ssesanga 1999, 65.
3. Aniku , Kataama, Nkedi-Kizza and Ssesanga 1999, 65.
4. Gladwin 1991 191, Gladwin 1991, 141
5. For more information see, FAO-UNESCO 1988, USDA-Agricultural Handbook 436 1999, and Radwanski 1960
6. Gladwin 1997
7. Vosti and Readon 1995

References

Allison, L.E. "Organic Carbon." In Methods of Soil Analysis, ed. C. A. Black, D.D. Evans, L.J. White, L.E. Ensminger, and Clark F.E. (Am. Soc. Agron. Madison WI, 1965), p. 1367.

Aniku J., D. Kataama, P. Nkedi-Kizza and Ssesanga S. PDCO and soil fertility management: Uganda results and experience. In R.N. Roy and H. Nabhan. Soil nutrient management in sub-Saharan Africa in support of the Soil Fertility Initiative. Proceedings of the conference held in Lusaka, Zambia 6-8 December, 1999. Food and Agriculture Organization of the United Nations, Rome, 2001. P. 65.

Bouyoucos. G. J. Hydrometer method improved for making particle size analyses of soils. Agronomy Journal 54, (1962):464.

Bremner, J.M.. Total nitrogen. In Methods of Soil Analysis , ed. C. A. Black, D.D. Evans, L.J. White, L.E. Ensminger, and Clark F.E. (Am. Soc. Agron. Madison WI, 1965), p. 1149.

FAO -UNESCO Soil Map of the World. World Soil Resources report 60. Food and Agriculture Organization of the United Nations, Rome,1988.

Gladwin, C. H. Fertilizer subsidy removal programs and their potential impacts on women farmers in Malawi and Cameroon. In Structural adjustment and African Women Farmers, ed. C. H. Gladwin (University of Florida Press. Gainesville, 1991), p. 191

Gladwin, C.H. Gendered impacts of fertilizer subsidy removal programs in Malawi and Cameroon. Agricultural Economics. 7, (1992): 141.

Gladwin, C.H., K.L. Buhr, A. Goldman, C. Hiebsch, P.E. Hildebrand, G. Kidder, M. Langham, D. Lee, P. Nkedi-Kizza and Williams. D. "Gender and soil fertility in Africa." American Society of Agronomy and Soil Science Society of America. Madison WI. Replenishing Soil Fertility in Africa. SSSA Special Publication No. 51, (1997), p.219.

Harrop J. F. Soils. In Agriculture in Uganda, ed. J. D. Jameson, (Oxford University Press, 1970), p. 43.

Olsen S.R., C.V. Cole, F.S. Watanable and Dean, L.A.. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Department of Agriculture Circular 939, (1954).

Radwanski, S. A. The Soils and Land Use of Buganda. Memoirs of the Research Division. Series 1: Soils No. 4, (1960). Uganda Protectorate, Department of Agriculture.

Soil Survey Staff. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. USDA, Agricultural Handbook 436. (US Government Printing Office, Washington, DC, 1999).

Stephens D. Soil Fertility. In Agriculture in Uganda, ed. J. D. Jameson, (Oxford University Press, 1970), p. 72.

Vosti S and T. Readon. Agricultural growth, natural resource sustainability and poverty alleviation. In Agricultural growth, natural resource sustainability, and poverty alleviation in Latin America: The role of hillside regions, ed.. O. Neidecker -Gonzales and S.J. Scherr (Proceedings of the conference held 4-8 December, 1995 in Tegucigalpa. Honduras. International Food Policy Research Institute, 1995.

Reference Style: The following is the suggested format for referencing this article: Nkedi-Kizza, Peter, Jacob Aniku, and Christina Gladwin. "Gender And Soil Fertility In Uganda: A Comparison Of Soil Fertility Indicators For Women And Men's Agricultural Plots." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a2.htm

Gender and Soil Fertility Management in Mbale District, Southeastern Uganda

ABE GOLDMAN AND KATHLEEN HELDENBRAND

Introduction

This paper explores gender-related aspects of agriculture and agricultural change in a densely populated, high potential area in eastern Uganda, particularly in relation to declining productivity in the region. Much recent literature has investigated the impacts of specific agricultural policies and projects on women farmers in sub-Saharan Africa [1]. In many cases, these policies and projects have resulted in unexpectedly negative consequences for women – and often failed in other objectives as well – to a large extent because they did not adequately consider the critical and complex roles that women play in most African agricultural systems. Far less often examined in the literature on gender, have been the chronic but pervasive impacts of persistently low agricultural productivity throughout most of sub-Saharan Africa. This stagnation is one of most striking and widespread features of agriculture in Africa today, and it stands in sharp contrast to the experience of most developing regions in Asia and Latin America. The impacts of this stagnation and decline in agricultural productivity are likely to be particularly severe for African women farmers, whose economic livelihoods are so closely linked to the production and sale of agricultural products and services.

The paper also examines gender differentiation in agricultural activities and resources in the survey region and the interaction of gender with other household and demographic characteristics. Many aspects of gender roles in African agriculture are more complex and variable than is often assumed, including the common assumption that women specialize in food crop production while men concentrate on nonfood cash crops. Moreover, important features of age and household structure overlap with gender in complex ways, and characteristics that are often interpreted as related to gender also involve other demographic and household variables. Finally, gender roles have been undergoing considerable change in response to changes in economic conditions, migration, and disease incidence (particularly HIV), among other factors, all of which have necessitated adaptation of traditional gender roles. As discussed below, in the survey region many activities, resources, and outcomes are

Abe Goldman is Associate Professor of Geography at the University of Florida. He has done research on small scale farmers and their adaptations to population growth and agricultural hazards, intensification, and local knowledge and resource management by farmers in areas of Kenya, Nigeria, and Uganda. **Kathleen Heldenbrand** received her BA in anthropology at Webster University, St. Louis, MO and her MA in cultural anthropology at the University of Florida,Gainesville focusing on human displacement and resettlement. She has spent the last ten years working in East Africa and in the U.S. She is currently adjunct professor at Webster University, St. Louis and assistant director of The African Refugee Service, located in St. Louis, MO.

http://www.africa.ufl.edu/asq/v6/v6i1-2a3.pdf

ISSN: 2152-2448

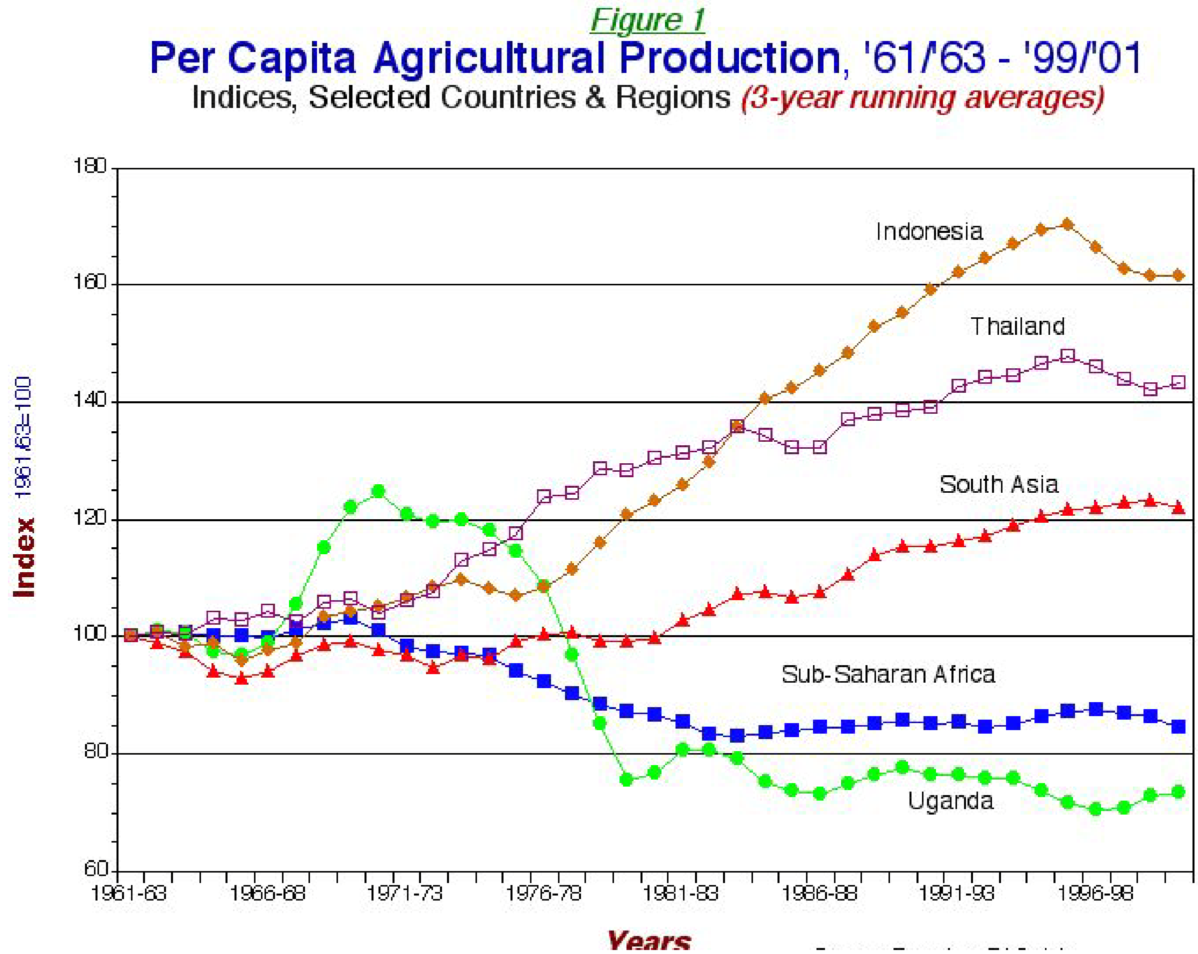
not differentiated solely by gender, and many of the activities and attributes of women and men farmers cannot easily be distinguished.

After examining some of the context of Ugandan agriculture, and comparing Uganda's experience to those of other regions in Africa and elsewhere, this paper reviews research data from a survey conducted in 1998 to explore the differentiation of agricultural characteristics and activities on the basis of gender and household structure. Recent trends in production and food security are then examined, also differentiated by gender and household structure. The conclusions address the current conditions and prospects of the agricultural systems of the area and the significance of gender and household structure to these.

UGANDAN EXPERIENCE AND CONTEXT

Much of Uganda, including the survey region in this study, is endowed with favorable agricultural conditions. Ample rainfall, divided between two rainy seasons in much of the country, and relatively fertile soils helped make southern Uganda one of the most productive areas of eastern Africa through the pre-colonial and colonial periods [2]. Uganda is estimated to have at least twice as much high potential land as Kenya [3]. The historic development of large agrarian populations, often associated with centralized states such as Buganda and others, testify to the long term productivity of the region. In the 20th century, agricultural output increased dramatically for most of the decade after independence – more rapidly in fact than most other developing regions in Africa or elsewhere (Figure 1). However, since the mid-1970s, Uganda has been plagued by more than two decades of severe political and social turmoil, combined with four decades of rapid population growth since 1960 and over three decades without agricultural input use, particularly for soil fertility improvement. These have all contributed to stagnant or declining productivity in agriculture and persistent rural impoverishment in much of the country.

The UN Food and Agriculture Organization (FAO) estimates that about 80% of Uganda's 1999 population of 22.6 million is agricultural and over 85% is considered rural [4]. These proportions are high even by African standards, and they indicate the continuing dependence on agricultural production in Uganda. Despite this, virtually no aspect of agricultural production in Uganda has been able to keep pace with population growth for the last two to three decades. Per capita agricultural production in Uganda declined steadily through the 1980s and most of the 1990s, and it is currently estimated to be about 75% of the level of per capita production in the early 1960s (Figure 1). Per capita production of food crops and of livestock, two of the components of total agricultural production, have similarly declined to 75% to 80% of their 1960s levels. The most dramatic decline, though, has been in nonfood ("cash") crops, which are currently at about 40% of the per capita level of the early 1960s. These are markedly more severe declines than those estimated for sub-Saharan Africa as a whole, for which per capita agricultural production in 1999-2001 is estimated by the FAO at about 85% of the 1961-63 level.



The Ugandan experience as well as that of sub-Saharan Africa as a whole are in marked contrast to the record of most developing Asian and Latin American countries. Per capita agricultural production in Indonesia, for example, is about 60% greater in 1999-2001 than it was in 1961-63, despite massive population growth there [5]. Less dramatic improvements have occurred in South Asia, where recent per capita production is about 20% higher than in the early 1960s. Nonetheless, this more modest improvement occurred despite a 130% increase in population over 30 years (to over 1.3 billion in 2000) and under conditions of far higher population density than found in sub-Saharan Africa.

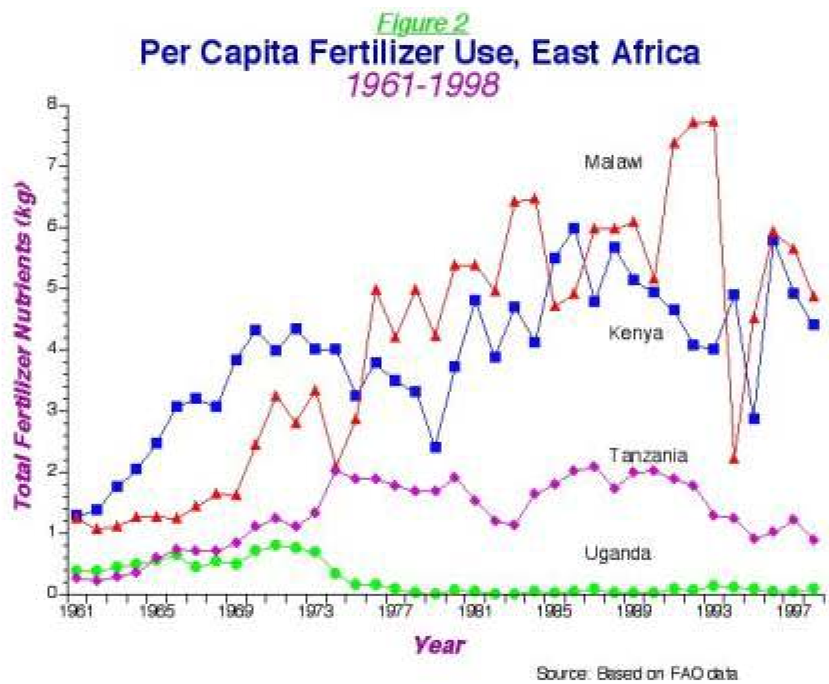
A substantial part of the failure of agricultural production to keep pace with population growth in Uganda and in most of Africa is due to the failure to increase agricultural productivity. Maize yields in Uganda, for example, are estimated to be at approximately the same level as they were in the early 1960s – approximately 1.1 to 1.3 tons per ha [6]. In contrast, maize yields in most countries of Central and South America, and South and Southeast Asia, which all started at levels about the same or lower than Uganda's in the 1960s, are now estimated to be two to three times as high. The same is true for Africa as a whole in comparison to other developing regions.

The single most important cause for the persistence of low productivity in African agriculture is probably the extremely low level of fertilizer use there, which contrasts sharply with all other parts of the developing world. Table 1 shows per capita use of total fertilizer nutrients – nitrogen, phosphorus, and potassium – in 1998 (the latest year for which FAO estimates are available) for sub-Saharan Africa and the other main developing regions of the world.

Table 1: Per Capita Use of Fertilizer Nutrients, 1998
(kilograms nitrogen, phosphorus, & potassium per capita)

World	Sub-Saharan Africa	Latin America	China	South Asia	Southeast Asia
23.3	3.4	22.3	27.8	16.0	17.1
Source: Calculated from FAO data [3]					

Even in view of the low and declining level of fertilizer use in most of Africa, Uganda stands out in comparison to other African countries, particularly in East Africa. Figure 2 shows fertilizer use per capita in Uganda in comparison with several other East African countries from 1961 to 1998. It illustrates the recent declines in fertilizer use in most countries as well as the notable absence of fertilizer use in Uganda for the last quarter century. Few countries in Africa, or in the world, particularly those with agriculturally-based economies, have experienced such an extended absence of fertilizer use over the period. As a result, even substantial reservoirs of soil nutrients such as found in the more fertile areas of Uganda will be severely depleted with increasingly intensive use. As in most developing countries, fertilizer subsidies were common in the early 1960s in Uganda. Following the economic disruptions of Amin's regime and subsequent conflicts, fertilizers were unavailable in Uganda except on the black market. They are now again available, but their trade is entirely privatized, with no government subsidies [7]. These conditions are further discussed below in relation to the responses of the farmers interviewed in the research survey.



RESEARCH SITE AND SAMPLING METHODS

Mbale District was selected for this study as a high potential region which is one of the three most densely populated rural districts in Uganda, the others being Kabale and Kisoro which neighbor each other in the extreme southwest of the country (Figure 3).

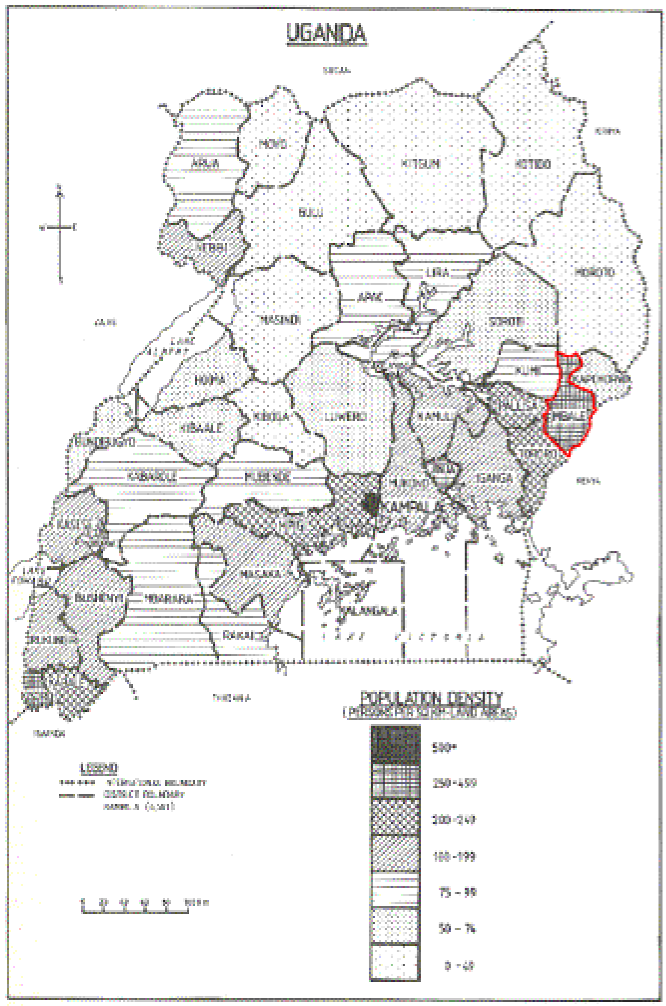


Figure 3: Uganda population density & location of survey area

Source: Uganda, 1994

At the time of the last national census in 1991, Mbale had a population of about 711,000, over 91% of which is rural, and a density of about 284 per sq km [8]. Projected district population in mid-1998 was approximately 905,000, which would imply a density of 361 per sq km and an annual growth rate of about 2.4% [9]. The district also had a sex ratio (the number of men per 100 women) in 1991 of 100.2, unusually high for a rural African region where male outmigration typically leaves many more women than men in rural areas. (By comparison, Kabale and Kisoro had 1991 densities of 246 and 301 per sq km and sex ratios of 90 and 86, respectively [10].) The average rural household size in Mbale in 1991 was 4.6.

Mbale has been relatively prosperous in comparison with other areas in Uganda. It has reasonably favorable agroecological conditions, including volcanic soils in much of the district, and fairly good rainfall (see below). Because it borders Kenya, it has had access to Kenyan input and output markets, and the western, relatively lower altitude, part of the district is quite well connected to Kampala and other urban centers of central and southern Uganda. Mbale town, the district capital, is about 240 km from Kampala along fairly good paved roads.

Mbale district is also a site of the USAID-supported Investment In Developing Export Agriculture Project (IDEA) to help develop export-oriented agriculture, including major food crops such as maize and beans, as well as a wide range of food and nonfood income crops. Numerous domestic and international NGO projects also work in the district, which includes the western portion of Mount Elgon and the Mount Elgon National Park. Together with its neighbor to the north, Kapchorwa District, which also borders Mount Elgon but has lower population density, Mbale is often seen as among the most agriculturally progressive areas in Uganda [11].

The district is physically divided between lower and higher altitude regions. The former are only relative lowlands, at altitudes of about 1500 meters, with flat or rolling landscapes. The highlands, with agricultural regions at 2000 to 2500 meters and higher, include areas of steep topography and often very fertile volcanic soils. Population density is generally very high in the high altitude areas, and roads can be extremely poor and often impassable in the rainy seasons. Mean annual rainfall ranges from about 1000 to 1700mm, divided into two rainy seasons, with higher altitude areas generally receiving higher amounts [12]. The northern lowland areas are drier than those in the south, and most of the northern region, both lowland and highland, is less well connected to transport networks and urban centers than southern areas. Soils in the lowlands are generally not as fertile as in the higher altitude areas, but population densities are lower, and roads and levels of access to markets and towns are considerably better. The northern lowlands have also in recent years been subject to cattle raiding by heavily armed Karamoja pastoral groups from the dry plains north of Mbale. The predominant ethnic group throughout the district are the Bagisu (or Gisu), who are considered closely related linguistically to the Luhya of the Kakamega region of Kenya.

Four villages were selected for this survey, two each in the lower and higher altitude regions and in the northern and southern portions of the district. The sample was stratified so that ten women and ten men were interviewed in each village, yielding a total sample of 80. Respondents were selected at random from lists of village households compiled by village leaders. Seventy one percent of the respondents are married, but the sample included eleven single women (28% of the women interviewed) and twelve single men (30% of the men).

In order to explore the gender and household aspects of agricultural activities and soil fertility management, the survey data discussed below is categorized into four groups: married men and women and single men and women. In some parts of Africa (particularly West Africa), married men and women have very distinctive responsibilities and activities, including separate crops, agricultural plots, tasks, and income sources [13]. As discussed below, such distinctions are far less marked in this region than elsewhere. Female-headed households figure prominently in much literature on gender. The group labeled single women represents most of the female-headed households in the survey sample. Their special characteristics in this sample are discussed below. Because of the low rate of male outmigration in the district, there were very few of what are sometimes termed “de facto female headed households” – i.e., households with a husband living and working elsewhere. Only two of the 29 married women in the sample said their husbands lived elsewhere for much of the year. Single men also emerged as a distinctive group, as discussed below.

The surveys dealt with household conditions and activities as well as gender distinctions in agricultural resources, activities, and incomes, with particular focus on aspects of soil fertility management and productivity. Current conditions and outcomes were compared with those in the past (ten years ago) to get a sense of trends. Some additional anecdotal material is also reported below. (There were few differences in gender-related characteristics among the villages, and as a result the villages are not dealt with separately in this paper.)

HOUSEHOLD SIZE, STRUCTURE, AND LAND OWNERSHIP & USE

Household Demographic Characteristics

Basic demographic characteristics of the respondents and their households, divided by gender and marital status, are shown in Table 2.

Table 2: Average Age, Household Size, & Age Distribution

	Total Sample (N=80)	Women (N=40)	Men (N=40)	Mar'd Women (N=29)	Single Women (N=11)	Mar'd men (N=28)	Single men (N=12)
Average age	41	42	40	34	62	41	39
Household size	6.1	6.4	5.8	7.1	4.5	7.5	1.6
No. adults (>18)	2.6	2.7	2.4	3.0	1.7	2.8	1.5
No. children (<18)	3.5	3.8	3.3	4.1	2.8	4.7	0.1
Adults/ children	0.7	0.7	0.7	0.7	0.6	0.6	18.0
% polygamous (N= 57)	37%			62%		11%	

The average age for the total sample is 41. While women and men differ only slightly in mean ages overall, there are sharp distinctions between the subsample of single women and the other categories. All of the single women are widows. Their average age is 62, and eight of the 11 single women are 60 or older. The single men, in contrast, have an average age of 39.

Married women are the youngest sub-sample, with an average age of 34; none of the married women is 60 or over. The average age of married men is virtually identical with the total sample mean.

An important implication of the age distribution of this sample is that for women, the effects of age cannot be distinguished from the effects of being a single female head of household. Life cycle features clearly play a significant role in characterizing the sample of single women in this case. The category of single women, as a result, should be seen as representing characteristics combining gender- and age-based characteristics. Although there is a substantial age difference between the single women and single men, both groups have far fewer adults in their households than do married households, and thus less available labor. (They also have considerably less land, as shown in Table 4 below.) An important difference between single males and females, however, is that the single women care for an average of almost three children under 18, often grandchildren, while most single men have no children in their households. This further reduces the amount of land per person in the female headed households (see below).

The average resident household size (i.e., the number of people resident in the household) is 6.1 for the sample of 80 respondents, with a total household population of 487. The gender and age and distribution of resident household members reported by the respondents is summarized in Table 3.

Table 3: Gender & Age Distribution of Household Residents

Age	Male	Female	Percentage
Over 60	5	18	5%
18 – 60	98	83	37%
Under 18	143	140	58%
Totals	246	241	100%

The approximate equivalence of male and female residents is consistent with the sex ratio for Mbale reported in the census data, but this is atypical of many rural areas in Africa where male outmigration usually leaves a substantially larger number of women in the main working age groups. The significantly larger number of men than women in the 18-60 age range (although somewhat offset by the preponderance of women over 60) is particularly striking. It suggests either that migration by young men is less frequent and/or migration by women is more frequent than elsewhere, or that there has been considerable return migration, or all of these. The very high proportion of young people, with almost 60% of the population younger than 18, is indicative of the high fertility rates of the country and in this region. The fact that the proportion of young people in the population is higher than it is for the country as a whole, suggests the influence of outmigration, although this does not seem to have been as gender-biased as it usually is.

Traditionally, the Bagisu have involved their children in household chores and agricultural labor at a very early age (as is true in most African cultures). Beginning at the age of six or seven, children are expected to perform chores including gathering water and firewood (mainly done by girls), weeding household plots, and tending livestock (mainly by boys). Household labor capacity changed substantially with the provision of free primary education in 1997. Primary education is mandated by law, and up to four children in each household are permitted free primary education (although additional costs are often collected by school personnel). Children still do some household labor after school, but households with children between the ages of 6 and 12 have lost at least some of the labor traditionally provided by these children.

Landholding Size and Trends

The Bagisu are patrilineal, and land is passed to sons. They are also patrilocal, and women generally move to their husband's family compound at marriage. (A brideprice is expected from the husband or his family, which has traditionally been paid in cattle or other livestock, though other forms of wealth may also now be used.) Survey respondents report that in recent years, land purchases have become common, and the sale of land is used as a source of quick cash. Land rental or borrowing for one or more seasons are also common, as reported below.

Household landholdings are extremely small, both in the lower and higher altitude villages and among all demographic groups, reflecting the high population density of the region. The average farm size across the total sample is 2.2 acres or about 0.9 hectares. (Acres are generally used below because farmers speak in terms of acres rather than hectares in estimating land sizes.) With an average household size of 6.1 persons, this represents a mean per capita landholding of 0.4 acres (0.15 ha) – very little land on which to produce both household food and income. Nineteen of the farmers (24%) have less than one acre, and 15 (19%) have over three acres. Only four farmers in the sample (5%) have more than five acres (about 2 ha) per household, and the largest landholding in the sample is 10 acres (4 ha). Household land is typically divided into several plots, with an average of 3.7 plots per household. Table 4 lists reported average landholdings, numbers of plots, land per capita, and the percentage of farmers who rent or borrow land, disaggregated by gender and marital status.

Overall, women and men respondents reported roughly similar total household landholdings, with women having slightly less than men. (With the exception of widows who retain some of their husband's land, women do not own land on their own in the region.) There are, however, sharp differences in landholdings between married and single households. Single men or women have less than half the land that married households have. However, when the amount of land per person is calculated, single men, with their small households, have the largest amount of land per capita of any subgroup, while married men and women have the same amount per capita – about half as much as single men. Single women have the least land per capita, reflecting the number of dependent children in their households and their low total land holdings. This is one of several aspects of poverty among households headed by single (older) women.

Table 4: Household Land Holding and Usage

	Total Sample (N=80)	Women (N=40)	Men (N=40)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
Land (acres)	2.2	2.1	2.3	2.4	1.2	2.9	1.0
Land per capita (acres)	0.42	0.34	0.50	0.38	0.24	0.38	0.80
Avg. no. of plots	3.7	3.3	4.2	3.7	2.3	5.1	2.0
% who rent or borrow land	46%	43%	50%	45%	36%	50%	50%

In addition to gender, age and life cycle characteristics are clearly involved in landholding for this sample. Elderly men and women both tend to have very small landholdings, mainly due to the passing of land to their children and the limited labor resources they have available. Three of the single men in the sample are over 50, and two of these have only a quarter acre. Similarly, two of the 11 single women have only a quarter acre of land, and another five have a half acre. In all of these cases, farmers are likely to rent land from others when they have available funds. Almost half of the sample borrow or rent land to plant in addition to the plots they own. Single women are the least likely to do so, while single or married men are most likely to rent or borrow land.

Although it might be expected that landholdings have been declining for most households, only 29% of the respondents indicated that their farm size has decreased over the past 10 years; 40% said their landholding has remained constant, and 31% said it has increased (Table 5). Male respondents, particularly married men, were much more likely to have increased their landholding over the period than women. This could be a result of additional land purchase or inheritance. Half of the single women and single men reported having less land than in the past, though for differing life cycle reasons. The single women were widowed and in general much of their previous household land would have reverted to their male children (or co-wives' children in the case of polygamous households; about 37% of the sample who responded were from polygamous households). The much younger single men might have less land than in the past as they moved out of their family compounds and established their own single households. Only one among the single males and females reports having increased cultivated land over the past 10 years.

Table 5: Land Currently Planted vs Land Planted 10 years ago

	Total Sample (N=58)	Women (N=30)	Men (N=28)	Married women (N=20)	Single women (N=10)	Married men (N=20)	Single men (N=8)
Decreased	29%	30%	29%	20%	50%	23%	50%
Increased	31%	20%	42%	30%	0	50%	17%
Same	40%	50%	29%	50%	50%	27%	33%

GENDER AND CROP & LIVESTOCK OWNERSHIP & MANAGEMENT

Gender identification of crops, livestock, and household farming plots is a common feature of African agricultural systems. Certain crops and livestock are often strongly identified as predominantly within a male or female domain, although this can vary considerably among cultures and is likely to change over time. In many African areas, it is common for nonfood income crops such as coffee, cocoa, and cotton to be principally men's crops. Women traditionally have primary responsibility for food crops, but gender identification is usually more complex than this, with the disposition of some food crops, often staple grains or root crops, controlled by men, while other foods, particularly many legumes, controlled mainly by women. Livestock also often are linked to male or female household members, with cattle more often being controlled by men and goats and/or poultry by women. But again, there are many variations, and considerable change is underway [14].

Various aspects of crop and animal management and their gender dimensions were examined in this study, differentiated by the four main gender and household categories: married and single men and women. In general, gender identification is less clearly defined in Mbale than it often is in other African agricultural systems, and age and/or life cycle characteristics are often strongly confounded with gender.

Main crops

The four main food crops in the region are starchy bananas (known as "matoke" in much of Uganda), cassava, maize, and beans (*Phaseolus vulgaris*), each of which is considered one four most important food crops by between 65% and 90% of farmers interviewed (Table 6). Sweet potatoes and cocoyam are also moderately important food crops. Coffee, beans, bananas, and maize are the most important income crops in most of the region, with various vegetables (tomatoes, cabbage, and onions) also important for some farmers and in some regions.

There are some gender distinctions in crops, but they do not as seem as sharp as in other areas of Africa or, possibly, as they were in the past. The main food crops grown by men and women are approximately similar, as are those considered main men's and women's crops. Bananas are considered the single most important crop by both men and women, married or single. Maize and cassava are somewhat more important to men, and beans, sweet potatoes, and cocoyam are somewhat more important to women. All of these, however, are commonly grown by both genders.

Among income crops, coffee is generally considered a men's crop, and it predominates among married men, but over half of single women also grow it, generally because they are widows who inherited their husbands' coffee plants after his death. Bananas and beans are important income crops for most households, and although beans are considered more a woman's crop, they are also grown by single men for income. Tomatoes, onions, and cabbages are also grown by women as cash crops and are sold in local markets. They are rarely if ever sold to traders for transport to distant markets. Other than those women who have inherited coffee, the produce women sell is generally only for local markets. In terms of gender identification of the main food and income crops, the responses indicate that although there are some differences, the distinctions are relatively subtle, and they may have become more flexible than they were in the past.

There are also some crop distinctions between married and single households of both genders. The main household income crops for married women are beans, coffee, bananas, and maize, in this order, with tomatoes, onions, and cabbages as additional income crops. Among single women, the main income crops are bananas, coffee, and beans. Maize, tomatoes and onions are less commonly grown by single women as income crops. Among married men, coffee stands out as the most important income crop, followed by beans, maize, and bananas. Tomatoes, onions, and cabbage, and in a few cases cotton, are also important income crops. For single men, bananas are approximately as important as coffee as an income crop, followed by beans, maize, and tomatoes.

Many of the responses as well as anecdotal information provided by the respondents, however, indicated that although specific crops sold by men and women may not differ substantially, their marketing patterns often do differ. Women often sell sold their crops only locally, either in front of their homesteads or at the nearest market or trading center. Partly because of their heavy domestic workload, they often tend to travel very little. Indeed, one of the female respondents said that she does not travel anywhere except to her plots and back, while her husband does all of the marketing. Although this is an extreme case, men generally travel much more than women, and they are much more likely to sell produce in more distant markets. In addition, women often report that they have limited control of the money they earn from crop sales or some of their other activities (see also Table 10 below), as the money is said to "go into the husband's pocket.

Table 6: Main Food & Income Crops

(a) Main Food Crops

Percentage of farmers listing crop as one of four main household food crops

	Total Sample (N=80)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
Bananas	90%	90%	91%	93%	83%
Beans	78%	86%	73%	79%	58%
Cassava	69%	62%	36%	82%	83%
Maize	66%	62%	46%	82%	58%
Sweet potato	39%	41%	64%	36%	8%
Cocoyam	29%	38%	46%	11%	33%
Millet	8%	10%	9%	7%	0%

(b) Main Income Crops

Percentage of farmers listing crop as one of four main household income crops

	Total Sample (N=80)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
Beans	62%	66%	55%	67%	50%
Coffee	60%	55%	55%	70%	58%
Bananas	52%	52%	64%	37%	67%
Maize	35%	41%	9%	44%	25%

Tomatoes	20%	21%	9%	22%	25%
Cabbage	14%	14%	18%	15%	8%
Onions	14%	17%	0%	22%	0%
Cassava	10%	10%	18%	7%	8%
Cotton	8%	10%	0%	11%	8%

Livestock

Livestock, particularly cattle and chickens, are a sign of wealth and a means of storing wealth among the Bagisu. Milk and eggs provide additional protein in peoples' diets, but meat is not a major element in their meals. When a household includes meat in a meal, the meat is most often purchased one or two kilograms at a time. The only time a cow is slaughtered for food is when the family is preparing a large ceremony or feast that will include extended family and community members. Otherwise, cattle are used almost exclusively for brideprice or gifts to young men preparing for their circumcision ceremonies.

While the people in this district are relatively poor, most households own at least some livestock, mainly cattle, goats, and poultry. About 70% of the sample households own cattle, and slightly more have poultry (Table 7). Slightly under half of the households own goats, and fewer than 20% own other livestock, mainly pigs or sheep. In general, single men's households are the least likely to have livestock. Most single females, in contrast, own cattle, poultry, and/or goats, having inherited them from their deceased husbands. While virtually all married households own some type of livestock, the women usually in these households do not own the major livestock themselves. Women own cattle in only about 10% of married households and they own goats in about 20% of these cases. Even poultry, which are often considered women's animals, are owned by women in only about one-third of the married households. (Knutsen [15] reports a roughly similar gender pattern of livestock control in southern Tanzania, but a much greater degree of female ownership and control in parts of northern Tanzania.)

A high proportion of women, both married and single, sell livestock products, notably eggs and milk. Eggs are somewhat more frequently sold by single women, and milk by married women. Married men are less likely to sell either of these, and almost no single men sell eggs.

Almost 80% of farmers in the total sample, and over 90% of male respondents, say they do not have enough feed for their livestock. A small proportion say they buy feed for their animals, but almost none of the women purchase feed. As discussed below, livestock provide manure for many of the farm households, even many of the female headed households, The constraints on feed resources, however, limits the numbers of animals and the amounts of manure available.

Table 7: Livestock Ownership, Sales, & Feed

Percentage of farmers

	Total Sample (N=80)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
Ownership (in household)					
Cattle	69%	76%	64%	71%	50%
Goats	46%	55%	55%	46%	17%
Poultry	73%	72%	73%	82%	50%
Ownership (by women)					
Cattle	18%	10%	55%	11%	0%
Goats	24%	24%	36%	18%	0%
Poultry	35%	35%	55%	29%	0%
Sales of livestock products					
Milk	31%	45%	36%	25%	8%
Eggs	38%	41%	55%	29%	33%
Feed supply					
Enough feed?	21%	38%	27%	7%	8%
Buy feed?	15%	7%	9%	25%	17%

FALLOW PERIODS, SOIL MANAGEMENT, & INPUT USE

The survey included questions on whether farmers maintain a fallow period on their fields and the length of fallow, the use of manure and other soil nutrient additions, the use of purchased fertilizer, and purchased hybrid maize seed. Leaving land fallow is one of the most important traditional means of soil fertility management, but with very high population density and very limited household landholdings, it is difficult for farmers to leave land unused on a regular basis. Farmers also often add animal manure and/or compost from crop and food byproducts to their fields to replenish soil nutrients. These techniques involve the collection, concentration, and recycling of nutrients already present in the local land use system, but they are limited by important material and labor constraints. Manure and compost have low nutrient concentrations relative to manufactured fertilizers, and large volumes and weights need to be carried to planted fields. Their use in many labor-based agricultural systems is limited to fields near the homestead, unless draft animals or other power sources are available to cart the material to outer fields. More extensive use is constrained by limits on the supply of organic material itself as well as the labor needed to transport and spread it over extensive fields.

Fallowing Practices

Even with fertile volcanic soils, fallow periods of several years are necessary to restore fertility after cropping, particularly in the absence of fertilizer use or the limited use of nutrient recycling techniques (see below). However, as might be expected from the small size of landholdings, fallow periods for most farmers in this sample are very short or nonexistent. Almost three quarters of the sample say they do not fallow their fields at all, and only 26% of the surveyed farmers report they maintain some fallow on their fields, with an average fallow period of two years (Table 8). These farmers plant their plots for an average of about three years before leaving them fallow. The length of fallow does not differ significantly between men and women who maintain a fallow period, but far fewer women than men do so: in the total sample, only six women (15%) vs. 15 men (38%) say they practice any fallow. Almost half of married men say they maintain some fallow period, a considerably greater proportion than any other group, including married women. Only one of the single women and two of the single men say they maintain a fallow period.

The general lack of fallow, and its brevity in the cases in which it is practiced together with the low levels of nutrient inputs (below), indicates that soil nutrients are almost inevitably being depleted in agricultural fields. Nutrients are continually removed through sale of agricultural products, erosion, and other social and natural processes. Unless lost nutrients are concurrently replaced, mainly through the use of fertilizers and/or other inputs, it can be expected that soil fertility in the region has declined and is likely to continue to do so. Indications of severe nutrient decline are discussed below.

Soil Inputs

One or more "traditional" techniques or inputs to maintain soil fertility – animal manure, compost, household refuse, and/or mulching – are used by almost all of the respondents, but, even with small land holdings, farmers do not believe that these inputs are available in sufficient quantity to offset fertility decline. Labor constraints also often limit their use, since all of these require high labor inputs. The most labor- and land-constrained households, which include most of the elderly single women, generally make least use of these inputs, since they generally have the lowest availability of both labor and materials. As a result, they would be expected to have the lowest yields and most severe yield declines.

Commercial fertilizers represent net imports of nutrients into agricultural systems – whereas the other techniques mostly represent a rearrangement and concentration of nutrients already present). Their high nutrient concentrations also largely overcome the labor requirements of traditional inputs, which have low nutrient concentration and thus high mass and volume. However, they usually require cash for purchase, and relatively few farmers in the region have previous experience with them, so few know much about their use or potential impacts on output. At the time of the survey, there were also relatively few shops or vendors selling fertilizers, though they were available in some rural locations.

(1) Manure use: About two thirds of the respondents use at least some animal manure, usually on plots close to the homestead and/or the animal stall. The most common use of manure is on bananas, although respondents say it is also used on coffee and maize. None of the respondents purchases manure; all of the usage is from animals owned or controlled by the household.

Somewhat surprisingly, the highest proportion of manure use is among married women, which may reflect intensive small plot cultivation. As noted above, ownership of cattle and most other livestock is roughly equivalent among married men and women (over 70% of married respondents own cattle). However, only 36% of single women use manure, considerably lower than any other group and lower than the proportion who own cattle or other livestock (Table 6 above). This suggests that labor constraints, even more than livestock availability, limit use of manure among these elderly single women.

Only a small minority, about 20%, of respondents say they have enough manure for their needs. The relatively small number of animals per household, due largely to limited grazing and other feed sources, is probably the main factor constraining the supply of manure.

An additional recent problem has appeared in some areas. Lower altitude villages in the north of the district have been repeatedly attacked by pastoralist Karamojong raiders from the north in the last several years, losing many of their cattle and other livestock. In addition to the insecurity and loss of wealth resulting from these raids, they have removed farmers' source of animal manure. News reports indicate that cattle raids in this area have continued through 2000 and 2001 [16]. Such loss of livestock to raiding is likely to accelerate soil fertility decline unless fertilizers or other soil fertility enhancements become more accessible

(2) Use of compost & household refuse, mulching, & agroforestry: Almost all farmers -- 94% -- report some use of compost or refuse on their fields, though mostly in plots close to the homestead. Bananas are the crop on which compost is most often used. The more labor intensive practice of mulching is reported by only 51% of respondents. Thirty percent of the respondents report some planting of trees specifically to improve soil quality. This has been promoted by some local NGOs, though less than one third of farmers report any tree planting for soil fertility improvement.

Use of all of these practices is roughly equivalent between male and female and single and married respondents. The one exception is that single elderly women report substantially lower use of agroforestry than other groups. This is probably due to the small sizes of their landholdings, which limits land available for tree planting (Table 4 above).

Due to the high degree of land use pressure throughout the region, none of these techniques for recycling or concentrating nutrients has great potential to significantly retard or reverse the general decline in soil nutrient supply and crop yields. To do so, all would require the utilization of considerable amounts of noncropped land -- for livestock forage, generating large amounts of biomass, and/or planting of nitrogen fixing trees. Such land reserves are simply no longer available in most of this area. Moreover, considerable labor would be required to disperse the manure or biomass to the crop fields, and farmers consistently say they have little or no labor available for this purpose. Finally, the sale of agricultural products outside the region implies an irretrievable export of nutrients. Thus, although these techniques may increase the efficiency of utilization of the existing nutrient supply, they can at best retard some of the decline in nutrient supply and cannot represent a long term solution, nor can they reverse the substantial declines in yield and output reported by farmers throughout Mbale, as discussed below.

Table 8: Fallow Periods, Soil Inputs and Hybrid Maize Use

Percentage of farmers

	Total Sample (N=80)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
% who fallow	26%	17%	9%	46%	17%
Avg fallow length (years)	2	2	2	2	1

Manure use	66%	83%	36%	64%	58%
Enough manure?	19%	25%	25%	6%	29%
Compost use	94%	100%	91%	86%	100%
Mulch use	51%	48%	46%	57%	50%
"Agroforestry"	30%	35%	9%	32%	33%
Fertilizer use (this or last season)	18%	24%	0%	25%	0%
Never used fertilizer	75%	72%	100%	64%	83%
Hybrid maize use	69%	76%	64%	75%	42%
Kg hybrid seed	5.2	4.4	2.8	6.0	6.8

(3) Fertilizer use: As noted earlier, there has been little or no use of fertilizers in most of Uganda for the past 30 years, in contrast to much of Kenya and, to a lesser degree, Tanzania [17]. A small number of farmers in Mbale have recently begun to use fertilizers to address declines in soil fertility, but it seems that this incipient trend has been arrested or reversed by sharply rising prices.

Fewer than 20% of farmers in the sample reported use of commercial fertilizers within the last two seasons, all of them in married households, with no difference between married men and women. None of the single women or single men were currently using fertilizers. Moreover, seventy five percent of the respondents have never used fertilizers. None of the single women, and only two of the single men had ever used them. Among those who regularly or occasionally use fertilizers, the average amount purchased was 11.5 kg.

Most farmers say they are aware of the benefits of fertilizers, having at least seen some of the demonstration plots that the Ministry of Agriculture and the IDEA Project have scattered through the district, mostly for maize. Some farmers who have not used fertilizers are also reluctant to begin because they have heard that once one starts using fertilizers, one cannot stop using them. (This belief is common in many areas where there is little or no use of fertilizers. Agricultural officials believe it reflects the inability to maintain higher yields without fertilizer use [personal communications].) However, the main constraint to use of fertilizers cited by farmers is cost. The current average price reported by respondents is about UShs 633 per kg (approximately US $0.60 at the exchange rate at the time of the survey). Although not very high in absolute terms, this price represents about a 65% increase over the cost five years earlier, and a 28% increase from the cost two years earlier. This price is comparable to the usual casual labor wage rate of about UShs 600 per day (about 5-6 hours of labor). The average usage of about 11.5 kg would cost about UShs 7300. In addition to the total expense, the lack of a mechanism to purchase fertilizers or most other inputs on credit is certainly a major constraint on fertilizer use.

With about 25% or less nitrogen content in the compound fertilizers, the average purchased amount of 11.5 kg would represent about 2.9 kg of nitrogen (the most common limiting nutrient). If this were distributed evenly over the approximately one hectare average landholding per household, it would represent an extremely small nitrogen addition to counter the large losses that occur regularly through crop sales and removal, soil erosion, and other sources.

The significance of these very low levels of fertilizer and other soil nutrient use (low even in comparison to other similar areas in East Africa) is suggested by a recent study of soil nutrient balances in three densely populated high potential districts in Kenya (Kisii, Kakamega, and Embu) [18]. The study estimated average net nitrogen losses for these three cases to be 71 kg per ha per year, despite farmers' use of fertilizers and manure and other organic inputs in all of these areas. The largest sources of loss of nitrogen and other nutrients were erosion, leaching, and harvested crops. Inputs averaged 21 kg per ha from fertilizers and 31 kg per ha from manure and other organic sources, both probably considerably higher than comparable input use in Mbale District. Similar processes of nutrient loss prevail in Mbale, and it is likely that net losses of nitrogen and other nutrients are more substantial in Mbale than in any of the Kenyan cases.

(4) Hybrid maize use: Hybrid maize varieties, developed and adapted to local conditions by Ugandan and Kenyan agricultural research stations, can potentially increase yields, particularly in combination with fertilizer use. Some hybrid varieties also mature more rapidly than local varieties, which may reduce drought and/or pest losses. However, new hybrid seed must be purchased each year by farmers, unlike traditional varieties or other open-pollinated improved varieties for which farmers can plant saved seed from the previous season. Hybrid maize use has been widespread in many areas of Kenya, including areas bordering Mbale for a long period, but hybrid maize adoption is more recent and less prevalent in Uganda.

In contrast to use of fertilizers, hybrid maize varieties are now widely grown throughout the Mbale region. Almost 70% of the total sample, and over 80% of those who grow maize, plant some hybrid seed (Table 8). Both men and women, including elderly single women, buy hybrid maize seed, though a smaller proportion of single men than any other group plant hybrid seeds. There are more substantial differences in the amounts of hybrid seeds purchased, however, with women overall purchasing about one-third less seed than men. Elderly single women buy the lowest amounts –- less than half what men generally purchase. Most farmers say they buy fresh seed each year and most report that hybrid maize gives them higher yields, even though only a small number use fertilizer with the seed. The demonstration plots and other efforts to distribute hybrid maize seed in Mbale by the Ministry of Agriculture and the IDEA Project have clearly had a substantial effect on its adoption.

PRODUCTION LEVELS AND TRENDS

Farmers were asked to estimate their most recent (1997) production levels for their main crops (usually bananas, maize, beans, and coffee) and to estimate output for those crops 10 years ago (or when they began farming if that was more recent). Such estimates, particularly for the past, are difficult to make accurately, of course, but they may at least give an indication of production trends in an area. An additional limitation to the data discussed below is that although total sample sizes for responses are reasonable (over 40, except for coffee), several of the subsamples are too small to be statistically significant. The results may nevertheless suggest current conditions and directions for future research.

Table 9 summarizes responses on current output and comparisons of present and past output levels for the four main crops. Current production is converted to per capita output based on the number of resident household members, with children under 18 calculated as equivalent to 0.75 an adult. The figures for 10-year change represent the mean percent difference between current and past output levels for each group. Overall, the responses suggest that farmers are producing considerably less of their main food crops than are required to meet the basic nutritional needs of their households. In addition, there are strikingly large and prevalent declines in output of the region's main crops.

The per capita output estimates for the three main food crops in Table 9 strongly suggest that farmers are not producing enough basic food for their household nutritional needs – although these figures are, of course, very rough estimates, those for banana production (in bunches) particularly vague. Farmers clearly must purchase additional food to meet their needs, as they in fact report doing almost universally (Table 10, below). (Animal products, particularly eggs and milk, also contribute to household nutrition, though output and availability of these was not investigated.)

Among the gender/household categories, single women report the lowest levels of staple food output per capita, with the lowest per capita production of maize and bananas, though their bean production may help provide some additional protein. The main reason for this is probably the severely limited land available to these households, which are typically composed of an elderly woman and several children. Interestingly, however, single women report a relatively high level of coffee output, about twice that reported by the married men. Sample sizes for all of the coffee production estimates are very low, however, and the confidence level for most of these responses is correspondingly low. Estimated per capita production of food staples by married men and women are roughly similar, although contrary to expectations, married men estimate a higher output of beans than do married women. It is possible that this represents inaccurate information by married men of bean production that is done predominantly by women. It may also indicate a growing importance of beans as an income earning crop for men as well as women, as suggested by the high estimated bean output by single men as well as by the high proportion of respondents of both genders who list beans as major income crops (Table 7). Overall, there are so few production estimates by single men that these are not statistically meaningful. The estimates suggest, however, that their per capita production of staples, particularly maize, is considerably higher than that of the other three groups. The small household size (in most cases just one person), and relatively high amount of land per capita of single males certainly is a major factor in their ability to produce more than the other groups.

The sharp decline in output reported by most respondents for their main food and income crops is one of the most striking findings of the survey. Over 80% of farmers who made output comparisons reported declines for each of their main crops: bananas, maize, beans, and coffee. The extent of reported declines in output was also dramatic. Farmers reported mean production declines of 44% for bananas, 39% for maize, 48% for beans, and 46% for coffee in comparing current output with output on their farms 10 years ago (Table 9). Since only about 30% of respondents said their farm sizes had declined over the period (see above), the major part of these output declines apparently resulted from lower yields per land area. Anecdotally, farmers also report that individual plants tend to be smaller and produce less edible output than in the past. Even those who are planting hybrid and other improved varieties and those using various forms of organic inputs (manure, compost, etc.) report disappointing harvests. The sharp declines in yields would presumably be due to the conditions discussed in the previous section – short fallow periods, and insufficient or no use of fertilizer or organic recycling and additions. In addition, disease and pest damage were reported to have increased for many crops, especially bananas, beans, and cassava, which contributed to the lower yields. The incidence and severity of several diseases may also be linked to low soil fertility.

There are several notable differences in reported production trends among the gender-household groups, though as noted above, the small size of some of the subsamples limits the statistical significance of the results. Single women in particular stand out as reporting the largest percent declines in production for three of the four crops. The decline of maize and bean production by single women was particularly severe and substantially greater than for any other group. The reported decline in banana production was comparable to the declines reported by married men. Many of the single women in the sample might have lost their husbands and/or given some of their land to sons over the previous ten year period, which helps account for the sharp output declines they report. Since almost all are still caring for children under 18, however, their household needs have not declined to the same degree as their productive capacity. Married men reported notably larger percentage declines in maize, banana, and coffee production than did married women, and roughly comparable declines in bean production. Indeed, married women reported lower declines in all four crops than did single women or married men. Single men stood out as the only group to report production increases, which were especially high for beans and coffee production (though as noted, sample sizes are very small for this group). The sharp contrast between single men and the other groups is probably largely a result of their youth; having recently begun farming on their own, they are likely to be producing more than in the past.

Despite the inherent uncertainties of these production estimates, if the farmers' estimates are even roughly accurate, they indicate that the agricultural system of this region is undergoing a profound production crisis, one whose reversal is not in sight.

Table 9: Per Capita Production (1997) & Ten Year Production Trends ('87-'97), Main Crops

	Total Sample (N=80)	Married women (N=29)	Single women (N=11)	Married men (N=28)	Single men (N=12)
Bananas (bunches)					
Per capita output*	8.2 (N=41)	8.5 (N=18)	6.2 (N=10)	9.2 (N=10)	9.2 (N=3)
10 yr change**	-44%	-32%	-54%	-58%	+80%
Maize (kg)					
Per capita output*	67.5 (N=59)	61.3 (N=20)	28.6 (N=10)	56.8 (N=22)	174.5 (N=7)
10 yr change**	-39%	-25%	-77%	-49%	+82%
Beans (kg)					
Per capita output*	19.5 (N=42)	12.9 (N=16)	18.1 (N=10)	19.2 (N=13)	21.7 (N=3)
10 yr change**	-48%	-42%	-73%	-53%	+338%
Coffee (kg)					
Per capita output*	26.2 (N=24)	33.8 (N=8)	25.5 (N=6)	11.7 (N=9)	100.0 (N=1)
10 yr change**	-46%	-27%	-71%	-67%	+300%

* Mean 1997 per capita household; children under 18 calculated as 0.75 adult household member

** Mean per cent difference between estimated 1987 and 1997 production of crop

FOOD SECURITY & FOOD PURCHASES

The production trends discussed above suggest that most farmers in the region are probably less food secure than in the past, except in cases where other income sources allow them to purchase sufficient food. In order to obtain a rough gauge of food security in the region, respondents were asked about food sufficiency from their own production, recent experiences of hunger, and food purchases and related income sources, the responses for which are summarized in Table 10. Given the reported declines in the region's output reviewed above, it is not surprising that almost all farmers now purchase food in addition to what they produce themselves, and that, for the large majority of respondents, their own production does not last until the next harvest.

Approximately half of the respondents report having experienced a period of serious hunger in their household at least once over the past 10 years. Only the younger single men among the demographic categories report a substantially lower incidence of such cases, which may be related to their ages as well as the small size of their households. A larger proportion of married men than other groups report hunger incidents. Fewer than half of the single women reported such incidents, contrary to what might be expected given the low production levels they report. This may be because they receive additional food from their adult children living nearby, especially in stressful situations.

Fewer than a third of the respondents report that the food they produce is sufficient to last until the next harvest. Single men appear to be best off in this respect as well, while single women are the worst off, with fewer than 20% having enough food to last until the following harvest. Their limited land and labor resources in relation to their household needs are probably the main causes of their widespread shortfalls in production. Only a quarter of the married men and women, who together comprise over 7% of the respondents, report that their food output lasts until harvest.

It is not surprising under these conditions that almost all respondents report that they buy food to supplement their own output. By itself, this can be an indication either of prosperity or low production, but given the current conditions in the area, it is most likely to indicate stress. The relatively low proportion of single women reporting food purchases is probably an indication of cash shortages rather than food security. Over 90% of each of the other groups, including single men, who seemingly have the most favorable ratio of output to needs, buy food. It should be noted that virtually all households also sell agricultural produce to obtain cash for basic needs and children's education, even when they don't produce enough food to last until the next harvest. Similar behavior appears in most of the studies in this collection.

Maize is the most commonly purchased food, with almost 87% of respondents reporting maize purchases, followed by rice (50% of respondents) and cassava (40% of respondents). (Rice is not grown in most of the survey areas, but it is planted in areas to the west of the survey region in Mbale and neighboring districts and is available in many local markets.)

Table 10: Aspects of Food Security

	Total Sample (N=76)	Married women (N=29)	Single women (N=11)	Married men (N=26)	Single men (N=10)
Hunger in last 10 yrs?	51%	52%	46%	63%	20%
Food lasts until harvest?	32%	25%	18%	25%	75%
Buy food?	93%	100%	73%	96%	91%
Sources of funds for food purchase					
Work for wages	36%	45%	46%	27%	20%
Sale of cash crops	50%	45%	27%	54%	80%
Borrow money	7%	0%	36%	0%	10%
Salaried employment	16%	14%	0%	27%	10%
Other business (incl. beer brewing)	11%	0%	9%	27%	0%

Sources of funds: The two main sources of income for food purchases are working for wages, generally on other people's farms, and the sale of crops. These are somewhat gender differentiated, with wage labor significantly more important for women, both married and single, and the sale of cash crops somewhat more important for men. About 45% of both single and married women report wage labor as an important income source, but this overshadows other income sources for single women, while many married women also sell crops for income. Only about 25% of the married men and fewer of the single men report wage labor as an important income source. They seem to rely to a far greater extent on the sale of crops for income. The usual casual labor wage rate in the region was reported to be about UShs 600 per day (though some food is also often included, and work is usually for about four to five hours).

This was roughly equivalent at the time of the survey to about US $0.60, which is low even by East African standards.

The sale of cash crops is important to both men and women, but it plays a particularly important role for men. Over half of married men and 80% of single men report earning income from crop sales. Single women are the least reliant on crop sales, probably because they have the least surplus production. (The sale of livestock, which is not listed in the table, is important for only about 8% of the sample.) Borrowing money is not a large income source overall, but it is especially important for the single women in the survey, a further indication of their relative impoverishment. Salaried employment and other business ventures were reported by a minority of respondents and were concentrated among married men. This is an indication of at least some of the greater diversity of income sources available to men that are generally available to women.

All of the data summarized in this and the previous sections suggest an endemically low level of agricultural productivity and welfare in the region, despite its seemingly favorable agro-ecological potential. Some of the implications of this, particularly with regard to gender, are discussed below.

SUMMARY OF GENDER AND HOUSEHOLD DISTINCTIONS

The survey results suggest that gender does play an important role in the agricultural resources, activities, and outcomes of farmers in Mbale, but many of its effects overlap and are linked with other important demographic characteristics. In particular, households headed by single males or females differ to a significant extent both from each other and from married households. Many of the distinctions are linked to age and dependents. Among married households, both men and women are usually heavily involved in agricultural production, which comprises their single most important economic activity. Although there are gender distinctions in some activities and in control of household resources, there are relatively few major differences among married men and women with respect to the variables examined in this study. The Mbale area itself is somewhat atypical in the high proportion of men who have remained here rather than migrating elsewhere. Both the official census data on sex ratios in Mbale District, and the gender distribution of household members cited by the respondents indicate the presence of an unusually high number of adult working age males in the region, even in these rural villages included in the survey (Table 3).

Married men are somewhat older than married women, but the households of married men and women are similar in size and in numbers of adults and children. Both have equivalent amounts of land on a per capita basis – an extremely low total of about 0.4 acres (0.1 ha) per person.

In contrast single women in the sample are older than any other group, and almost all are widows who care for two or more children. They comprise virtually all female headed households in the sample, as a result of which the effects of age and widowhood are interlinked with the effects of gender for this category. Because of the high number of working age men who have remained in the region, there are almost no households in the sample with absent male household heads who have moved to distant urban areas. The female headed households have the lowest amount of land per household member – about 35% less than married men or women – and none has more land than they had 10 years ago. In contrast, single males are generally younger unmarried men with no dependents. They have little land and fewer livestock than other households, but because of their small household size, they often have more land and produce higher output than others on a per capita basis.

There are few major distinctions in the types of crops grown by women and men in married or single households. Even coffee, the main nonfood income crop, is grown by similar proportions of households of different kinds, including those headed by single women. Men are more mobile, however, and have a wider range of marketing outlets, and they generally have control of most income generated by the household. Livestock ownership is common among all types of households, including female headed households. In married households, however, men generally have actual ownership of major livestock, particularly cattle and goats. Among the household types, those headed by single males are least likely to have livestock.

Many aspects of soil management and input use related to soil fertility are also roughly similar among men and women in married households, but single female headed households are disadvantaged in a number of respects. Fewer single women than others fallow their fields, or use manure or agroforestry techniques, and none use fertilizers. They do use compost and mulch, and plant hybrid maize at proportions comparable to married households, but they plant less hybrid seed than married households.

Single women also report the lowest per capita output of the two main staples, bananas and maize, as well as the most severe declines in output over the past decade for all four main crops. Male and female respondents in married households also report low output levels and sharp declines in output for each of these crops. Single males, are the only group to report gains in output over the last decade, and they have the highest per capita output of some crops, notably maize.

Finally, most indicators suggest that single women are less food secure than other groups and have fewer income sources for food purchases. Household food production is usually not sufficient to last until the next harvest for married households, but it is even less likely to be sufficient for single female headed households. Single males stand out from the others, however, in that 75% report producing enough food to last themselves until the next harvest. The absence of dependents is probably the key factor in this. In general, women's sources of income for food purchases are tied mainly to doing agricultural work for wages, while men are more likely to earn such income from crop sales. Single women in particular are heavily reliant on wage labor and to some extent on borrowing money for food purchases. Their food security, and that of their dependents, as a result, is especially closely tied to the state of the agricultural economy, in terms both of their own production as well as their employment.

CONCLUSION: ARE WOMEN HARMED BY LOW SOIL FERTILITY?

In comparison with many other areas of sub-Saharan Africa, an unusually high proportion of adult men remain in Mbale and are involved in agricultural activities there. Perhaps in part because of this, many of the traditional gender distinctions found elsewhere, such as gender identification of crops, livestock, and various activities, are less apparent here. Men still have greater control of household resources, however, and a greater range of economic activities than women. Women's economic livelihoods and their income sources are especially closely linked to agricultural production, both through wage labor, their most common income source, and sale of crops and livestock products. They are particularly vulnerable, as a result, to low and declining agricultural productivity, whether it occurs as an acute short term crisis, or as a more chronic process of decay. Single women with dependents are the most vulnerable group among those surveyed, although they are often assisted in crisis situations if they have adult children living nearby. The whole regional economy is of course dependent on agriculture and is affected by low productivity. But men have a somewhat greater range of economic activities, and so may be slightly less vulnerable. Most women have almost no other alternatives.

Intensive, almost continual land use is essential in much of Mbale, as in other areas of very high population density. Soil fertility is likely under these conditions to become the key limiting factor to increasing production or even to maintaining output at previous levels. Soil nutrients must be replaced to maintain productivity over time; they must be increased to raise productivity. Farmers in this survey indicate that output and yield levels are currently extremely low, and they have in most cases declined substantially over the last decade. Traditional organic techniques of soil fertility management are widely practiced, but they have apparently not been able to arrest the decline of productivity and output. Little surplus is available for sale as a result, and crop sales, which are the most common source of funds for most farmers, can generate relatively little income, either for food purchase or for agricultural or other investment.

Low productivity also guarantees low wages, and these have severe negative impacts on women farmers in general and single elderly women in particular, who rely so heavily on wage income and who remain impoverished as a result. At the low level of wages in Mbale, wage labor is incapable of providing more than a supplement to bare subsistence, and it is difficult or impossible for farmers to purchase inputs of any kind to increase productivity, especially fertilizers, or to devote labor to improving output on their own land.

Crop sales usually have a greater potential than wage labor for capital generation and incentive for reinvestment in order to increase productivity. Crop sales are an important income source for women as well as men, but single elderly women are the least able to take advantage of them. In addition, crop sales imply an inevitable export of the nutrients embodied in the product. Given the small size of agricultural holdings in Mbale, as well as the short or nonexistent fallow periods, the limited sources of local biomass or biomass import, and the common absence of fertilizer use, crop sales also accelerate the decline of soil productivity.

It will not be possible to increase agricultural productivity without substantial increases in soil nutrient supply. The most effective way of accomplishing this is through the import of nutrients in the form of fertilizers, which has been an essential and ubiquitous component of strategies for increasing productivity in all world agricultural regions in the 20th century, especially areas of high population density, as illustrated in Table 1 and Figure 2. Uganda has in this respect dramatically lagged behind even other countries of eastern and southern Africa.

The market cost of fertilizers and its rapid recent increase is the main obstacle to fertilizer use reported by farmers. Even farmers who had begun to experiment with fertilizer use were reducing or giving up on it in the face of rising costs. This is not surprising given that the current cost of a kilogram of compound fertilizer is roughly equivalent to a day's wage earnings. Wages are not likely to increase in the absence of increases in productivity, but productivity cannot increase in the absence of significant increases in soil nutrient supply. Fertilizers are the only effective way to substantially and rapidly increase soil nutrients and productivity, especially in this and other high density regions. This argues strongly that reliance on market prices will not result in rapid or significant increases in fertilizer use in this kind of region. To accomplish this end and achieve any significant improvement in agricultural welfare in this area, it will probably be necessary to subsidize the cost of fertilizers, or at the very least, the cost of borrowing cash for fertilizer and other input purchase. Otherwise, stagnation in production and welfare are likely to continue, and the impacts on women farmers who rely so heavily on agricultural wage labor and crop sales, will continue to be especially severe.

Acknowledgements

This study is based on research done for the Gender and Soil Fertility project, supported by the Soils CRSP, in July through November 1998 by Abe Goldman and Kathleen Heldenbrand of the University of Florida. Valuable assistance was provided by the USAID IDEA Project in Uganda, particularly Mark Wood in Kampala and Mathilda Makabay, coordinator for the IDEA project in Mbale. Additional advice and assistance was provided by the East African office of CIAT (the International Center for Tropical Agriculture), particularly Drs. Charles Wortmann, Soniia David, and Roger Kirkby. Research assistants in Mbale who contributed greatly to the project through their knowledge and efforts were Kate Nafuna, James Makoba, Angela Ayo, Alex Jigga, and Josea Malissa, who work with the Ministry of Agriculture and/or local NGOs in the district.

Notes

1. Carney, 1992; Francis, 1997; Gladwin, 1992; Meeker and Meekers, 1997; Sorensen, 1996; Schroeder, 1999.
2. The best rainfall and soil conditions in Uganda are mostly found in the southern half of the country, which have historically corresponded with the areas of greatest agricultural output and of highest population densities in colonial and immediate precolonial eras. These included the areas around Lake Victoria, the southwest of the country (currently comprising Kabale and Kisoro Districts), and the area around Mt. Elgon in the east of the country, currently comprising Mbale District (Uganda, 1967; Van Zwanenberg and King, 1975).
3. Van Zwanenberg and King, 1975.
4. FAO, 2001.
5. FAO, 2001.
6. FAO, 2001.
7. Makabay, 1998; Laker-Ojok, 1995.
8. Uganda, Republic of, 1996.

9. Uganda, Republic of, 1996.
10. Uganda, Republic of, 1996.
11. Kirkby, 1998.
12. Uganda, Republic of, 1967.
13. Fisher, et al., 2000; Guyer, 1991; Martin, 1984.
14. Knutsen, 1999.
15. Knutsen, 1999.
16. Odeke, 2001.
17. FAO, 2001.
18. Van den Bosch, et al., 1998.

References

Carney, Judith. 1992. "Peasant women and economic transformation in The Gambia." *Development and Change* 23: 67-90.

FAO (Food and Agriculture Organization of the United Nations). Website (www.fao.org). FAOSTAT (statistics), 2001.

Fisher, Monica; Rebecca Warner, and William Masters. 2000. "Gender and agricultural change: crop-livestock integration in Senegal." *Society and Natural Resources* 13: 203-222.

Francis, Elizabeth. 1997. "Gender and rural livelihoods in Kenya." *Journal of Development Studies* 35 (2): 72-95.

Gladwin, Christina. 1992. "Gendered impacts of fertilizer subsidy removal programs in Malawi and Cameroon." *Agricultural Economics* 7: 141-153.

Guyer, Jane, with Olukemi Idowu. 1991. "Women's agricultural work in a multimodal rural economy: Ibarapa District, Oyo State, Nigeria." In *Structural Adjustment and African Women Farmers*, ed. by Christina Gladwin. Gainesville: University of Florida Press. pp. 257-279.

Kirkby, Roger. 1998. Personal communication. (CIAT station head, Kawanda, Uganda.)

Knutsen, Glade. 1999. Small-Scale Dairying in Two Intensive, High Altitude Farming Systems in Tanzania: Labor and Gender Roles. PhD dissertation, Department of Geography, University of Florida

Laker-Ojok, Rita. 1995. "Managing input supplies for small farmers in Uganda: a problem of institutional change." In Uganda: Landmarks in Rebuilding a Nation, ed. by P. Langseth, J. Katorobo, E. Brett, and J. Munene. Kampala, Uganda: Fountain Publishers.

Makabay, Mathilda. 1998. Personal communication. (Ministry of Agriculture, Mbale District.)

Martin, Susan. 1984. "Gender and innovation: farming, cooking and palm processing in the Ngwa region, south-eastern Nigeria, 1900-1930." *Journal of African History 25:* 411-427.

Meeker, Jeffrey & Dominique Meekers. 1997. "The precarious socioeconomic position of women in rural Africa: the case of the Kaguru of Tanzania." *African Studies Review* 40 (1): 35-58.

Odeke, Abraham. 2001. "Meeting Uganda's warriors." BBC news, Oct. 23, 2001. (BBC website.)
Schroeder, Richard. 1999. Shady Practices: Agroforestry and gender politics in the Gambia. Berkeley: Univ. of California Press.

Sorensen, Pernille. 1996. "Commercialization of food crops in Busoga, Uganda, and the renegotiation of gender." *Gender and Society* 10 (5): 608-628.

Uganda, Republic of. 1996. Statistical Abstract, 1996. Entebbe: Statistics Department, Ministry of Finance and Economic Planning.

Uganda, Republic of. 1994. The 1991 Population and Housing Census. National Summary Statistics Department, Ministry of Finance and Economic Planning. . Entebbe, Uganda

Uganda, Republic of. 1967. Atlas of Uganda. Second edition. Department of Lands and Surveys, Uganda.

Van den Bosch, H.; J.N. Gitari; V.N Ogaro; S. Maobe; and J. Vlaming. 1998. "Monitoring nutrient flows and economic performance in African farming systems, III: Monitoring nutrient flows and balances in three districts in Kenya." Agriculture, Ecosystems, and Environment 71: 63-80.

Van Zwanenberg, R. and Anne King. 1975. An Economic History of Kenya and Uganda, 1800-1970. London: Macmillan.

Reference Style: The following is the suggested format for referencing this article:Goldman, Abe and Kathleen Heldenbrand. "Gender and Soil Fertility Management in Mbale District, Southeastern Uganda." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a3.htm

African Studies Quarterly | Volume 6, Issues 1 & 2 | Spring 2002

Diminishing Choices: Gender, Small Bags of Fertilizer, and Household Food Security Decisions in Malawi

ROBERT P. UTTARO

Abstract: This paper examines two decisions farmers in southern Malawi make every planting season: whether or not to acquire increasingly expensive chemical fertilizers and whether or not to buy and plant equally expensive hybrid maize seed. Both choices are interrelated. Maize is the staple food crop in Malawi and the key to food security; and traditionally, 95 percent of the total land area cultivated in maize has been planted to local open-pollinated varieties instead of the newer semi-flint hybrids. Local maize is very popular with smallholder subsistence farmers as is hybrid maize, that when fertilized, intensifies production improving food security at both household and national levels. In the current economic environment, however, planting hybrid maize has two drawbacks. The first is the high price of seed and the second is its high requirements of fertilizer. With fertilizer unaffordable to many farmers, especially to women farmers of poorer female-headed households, planting hybrid maize is impractical. This paper disaggregates Malawi's farmers into subgroups of men, married women, and female headed households, describes the decision processes they make, and examines whether small bags of fertilizer will make any difference to the dilemma they now face.

Introduction

It is the middle of September 1998 in Mayaka trading center in the southern region of Malawi. Just on the edge of town, there is an ADMARC, Malawi's agricultural marketing parastatal established in the early post independence years as is the key player of the Malawi government's relationship with the peasants [1] . As at so many other ADMARC centers at this time of year, people start queuing here early in the morning, waiting to buy whatever amount of maize they could afford to feed their families.

A woman in that line comes to ADMARC twice a week to buy maize for her family – if she has any money. There is absolutely no money for other necessities, such as soap, sugar, etc. She is no longer married as her husband died a few years ago. She is the main provider for her family. Her village is approximately six kilometers away and she walks the distance. She cannot afford to spend what little money she has on transport. The queue is long now, and so is the wait. The hungry season is upon her and will remain so until the first green maize is harvested sometime in late February or early March. In the coming year, if the rains are good and are on time, she and her family will be eating their own maize grown in her small garden. However, she now plants local maize and this means the hungry season will linger for a greater stretch because local maize takes longer to mature. Nevertheless, she is prayerful of a good

Robert P. Uttaro is a graduate student at the University of Florida finishing up a PhD in political science. He spent 16 months in Malawi between 1996 and 1998.

http://www.africa.ufl.edu/asq/v6/v6i1-2a4.pdf

ISSN: 2152-2448

harvest when she will gather in enough maize to keep her family fed until the end of October when the maize will run out and the hungry season returns. That is when she will begin her twice-weekly walk to ADMARC to buy maize – if she has money.

In that September of 1998, if she wanted to buy a 50kg bag of maize, she would have paid Malawi Kwacha (MK) 350. In September 2001, she would most likely not be buying at ADMARC due to ADMARC's low maize stocks. [2] Having to turn to the private market, the price would range between MK 15 – 17/ kg. If she continued to buy into December 2001, the price would be MK22 to MK25 / kg or MK1175 for a 50kg bag, three times as much as the price three years ago.

Maize is not the only commodity that has risen in price. Over the last half dozen years, the inflation rate has ravaged what meager savings she could scrape together. 1995 was the worst when food prices went up 133% while overall inflation was 98% (FEWS). By 2001, according to the National Statistical Office of Malawi, the inflation rate stood at 25% but this certainly was not the case with maize. No one would dare use this number to try to tell her that things were getting better. She knows better. She knows food is unaffordable as is the fertilizer she needs for her crops. She knows that the price for CAN went from MK 265 for a 50kg bag in 1998 to MK662 in 2000; that 23:21:0 + 4s went from MK347 to MK837 in the same period. If inflation is coming down it isn't on what matters most to her. And she knows that in this same time period her kwacha buys far less than it used to while the wages she earns doing casual labor – what is called "ganyu" - has remained stagnant.

Her food security situation is not exceptional. Many smallholder and subsistence farmers, men and women, are no longer able to produce enough food for their families. They are subsistence farmers who cannot afford the inputs necessary for an abundant harvest. It is a sad reality for far too many families in Malawi today. Even under the most favorable climatic conditions, they cannot afford to purchase fertilizer ever since the subsidy was removed under structural adjustment reforms, which started in 1986 and were not really effective until 1994. [3] Without fertilizer, the soil doesn't produce enough maize. Without fertilizer, they plant less hybrid maize, an expensive but less risky alternative to local maize. And with less maize, the number of households affected by an ever-deepening crisis of food insecurity is steadily increasing. [4] Njala – the Chichewa word for hunger – is heard in villages throughout Malawi.

Malawi's soils are losing their ability to produce. Food self-sufficiency is a distant and fading goal. Declining soil fertility is constraining food production and has been for a number of years now. [5] This fact was clear to everyone - not only the farmers themselves back in 1996, but also agronomists and soil scientists, technocrats and politicians. Poor yields and hungry children provide disturbing yet ample evidence of a problem growing only worse every day. As the price of fertilizer exceeds farmers' reach, hunger spread throughout the country and the hunger season lengthens. As the depletion and degradation of Malawi's soils continues people who depend on these soils for subsistence are finding that their options to deal with the crisis are severely limited.

This paper examines two of those options, the use of inorganic fertilizer and the planting of hybrid maize. Both options are interrelated. Maize is the staple food crop in Malawi with two general categories: local and hybrid. Local maize is very popular and many smallholder subsistence farmers plant it. Hybrid maize was developed to intensify production and therefore improve food self-sufficiency. Compared to local maize, hybrid has two distinct advantages. First, it produces significantly higher yields. Second, it matures much faster than local maize and minimizes the risk of crop loss if the rains should happen to end sooner than normal.

In the current economic environment, however, planting hybrid maize has two significant drawbacks. The first is the price of the seed. Whereas local maize seed can be obtained from the previous years crop, hybrid seed needs to be purchased in order to maintain the advantage of higher yields. The other drawback is the requirement of fertilizer. Hybrid is now an expensive investment. [6] With fertilizer now out of the reach of most smallholder farmers, planting hybrid maize is much riskier. Unfertilized hybrid maize yields generally are not that significantly better than local maize to justify the price of the seeds, although research has shown that in certain climatic and soil conditions it can be. Nevertheless, farmers have seen a steep increase in the prices of both hybrid seed and fertilizer causing many to reconsider the risk of planting hybrid. Using money for unfertilized hybrid seed might be better spent on something else.

Weather has to stand out as the greatest risk all farmers face for the obvious reason that it is outside human agency. Decisions concerning hybrid maize and fertilizer are riskier for poor households in part because the weather can devastate the household's thin economies. If the rains are heavy and the hybrid crop is washed away or the fertilizer leeches through, a significant loss is incurred. Even though rain patterns vary considerably throughout the country, in the past two years floods and drought have devastated much of the country. Many farmers fortunate enough not to have suffered from the flood in 2001 may not have been so lucky in escaping the ravages of the current drought. It seems likely that these experiences will affect future decisions concerning planting hybrid maize. [7]

Although food production is an important aspect of household food security or insecurity, it is not the only one and focusing only on increasing production would not necessarily convert a household from being food-insecure to being food-secure. Other factors certainly influence a household's food security including land size, family size, poverty and outside or off-farm income generating activities, to name just a few. [8] Thus, a household with only 0.35 hectares (ha) of land, limited income, high poverty and seven mouths to feed most likely will never be able to produce enough food to be food secure.

Nonetheless, a trend of increasing production is a key factor contributing to achieving both household and national food security particularly for the poorest countries. [9] For Sub-Saharan Africa, and particularly Malawi, it will not be an easy task. In order to meet nutritional requirements by 2008, grain yields will have to increase by a rate 60% higher than achieved during 1980 –1997. [10]

Increasing production would help close the food gap –shorten the hungry season – and have a positive impact on an impoverished family, simply because the less frequently food is purchased during the hungry season, when prices are typically high, means that more cash can be spent on other necessities. [11] Thus, decisions made by subsistence farmers– particularly women farmers who usually produce the subsistence crops in Malawi– that affect production and yields are vitally important in addressing household food security and poverty.

HOUSEHOLD FOOD SECURITY

The concept as well as the locus of food security has evolved since the early 1970s. Up until the mid – 1980s, analyses of food security were concerned with increasing national food stocks and stabilizing the supply of basic staples. [12] Since the mid -1980s and much due to the writings of Amartya Sen, however, the focus shifted to one of identifying the particular households that were food insecure and increasing their access to reliable food supplies. National food security is now recognized as a necessary but not a sufficient condition for household food security. [13] Household food security is a better construct as it reveals a multidimensional perception of all the factors contributes to food security beyond the supply-side factor of aggregate food production. Household income and poverty on the demand-side of the equation are now considered key in determining whether a household is food secure or insecure. [14] Viewing food security in this way show poor households caught in a vice: they are limited in their ability to purchase food outright while at the same time unable to increase production due to inadequate resources for sufficient inputs (i.e. seed, fertilizer) at the proper time.

As the concept of food security evolved, various themes and sub-themes appeared in the literature. [15] By the late 1980s and early 1990s, nutrition became an important measurable variable in defining household food security and determining whether households were food security. [16] Households are now considered food secure when they are "able to obtain adequate levels of food, either through home production, purchases or exchanges, to maintain a healthy and active life throughout the year". [17] Household purchases of food now become as important as household production of its own food. In addition, household self-sufficiency in food does not guarantee adequate nutritional levels within the household. [18] Intra-household distribution of food may be skewed such that there are individuals within the family who are malnourished.

If adequate nutritional levels are to be achieved and sustained, then reducing poverty and increasing incomes become parallel streams of concern. Sen suggests that more emphasis should be placed on reducing poverty than introducing technologies to increase food production with food insecure households, because they will never be food self-sufficient. Farmers with little land – 0.3 hectares or less – are chronically food insecure when they depend on their own food production. [19] These smallholders either have to find off farm work, be involved in income generating activities, or grow crops for sale. It is this latter point that growing hybrid maize addresses, although clearly not the only reason to grow it. Yet even hoping to sell hybrid to raise cash is problematic for food insecure smallholders as they tend to sell part of their hybrid maize crop right after harvest, partly because it does not store well and partly due to a great need for cash in the household at the end of the hungry season. [20]

Achieving goals of healthy nutrition and food security are intimately linked with issues of poverty alleviation and human resources development. In turn, these issues cannot be adequately engaged without a thorough understanding of gender relations and the role women have in the household. It is therefore necessary to investigate who makes the decisions regarding production, income generation, and crop selection within the household.

GENDER AND HOUSEHOLD FOOD SECURITY

There is no denying that the role of women in agriculture in Africa is extensive [21] . The importance of women in this vital sector was first introduced in Boserup's seminal work *Women's Role in Economic Development* in 1970. Since then, a burgeoning field of research has built on her pioneering work deepening our understanding of the vital position women occupy in food production and their primary position in the household decision process. Even so, it is a sad commentary that women's concerns continue to garner less attention in the food security literature than their obvious prominence would seem to argue for [22] .

This research explores the role of gender and gender relations as they affect food security. How these relations are constructed and maintained reveal much in determining resource distribution within the household. Particularly salient in the study of household food security in Sub-Saharan Africa is how gender factors into a multitude of decisions including what to produce and how to produce it, land allocation, how money should be spent in the acquisition or production of food and what are the opportunities and choices in the decision process. In addition, analysis through gender allows for greater attention to be paid to the constraints that limit women's productivity and the effect on women's workload. [23]

Agriculture is the mainstay of Malawi's economy with over 80% of the population either directly or indirectly dependent on it for their livelihood and welfare. According to statistics from the Ministry of Agriculture, women are the dominant agricultural labor force. In 1993, 92.5% of female labor was involved in agriculture compared to 69.3% of men. [24] Over 30% of Malawi's GDP is produced by agriculture with two - thirds coming from the smallholder sector. Since the mid-1990s the smallholder sub-sector is made up of nearly 1.8 million farms dominated by women with estimates of 30-40% of the families' being female headed. Disturbingly, half of the female-headed smallholder households do not reach the 40th percentile of income, as compared to a third of smallholder male heads of households. [25]

Landholding size has a pronounced effect on the success of smallholder agriculture, as does labor availability and money for inputs like seed and fertilizer. Therefore, it also has an equally pronounced effect on household food security. In 1991/92, 41 percent of smallholders had farms of less than half a hectare. [26] As population pressures increase, landholding size is expected to shrink from 0.46 ha per person in 1987 to 0.31 ha by 2001. [27] The logical conclusion is as clear as it is distressing: already impoverished farmers with the smallest landholdings, half of whom are female headed households (FHHs), will bear the brunt of this downward spiral. [28]

In Malawi, women play a predominant role in producing, storing, processing and preparing food for the family. They concentrate on growing food for their family's consumption compared to men who are often more involved in growing cash crops. As a result, cash income is much less for women as they tend to be involved much more in informal income generating activities. The small amounts of cash these activities provide are very often used to buy additional food to make up for shortfalls. [29]

It is clear that gender and household food security are essentially and fundamentally linked in Malawi as they are in most of Africa. [30] And just as in Malawi, the need to find ways to increase food production is essential as increasing populations and declining soil fertility are creating intolerable conditions for millions. However, advances in food production are constrained by the "invisibility factor," i.e., women do most of the food farming but have little access to the means necessary to significantly increase output and yields. [31] Although African women supply 46% of the agricultural labor and in some societies produce up to 80% of the domestic food "women's yields, women's adoption, and women's uses of inputs are rarely reported." [32] Agricultural experts seldom recognize that most of Africa's smallholders are women. [33] While rightly contending that the effectiveness of development strategies hinges on reaching African smallholders, they make the costly error of ignoring the fact that the constraints facing women smallholders may be an important part of the problem. The disconnect is as appalling as it is frustrating. The key role that women play in procuring adequate supplies of food for their families on a sustainable basis shows that food security is a prime concern for them.

RESEARCH SETTING

The overall purpose of this research was to ascertain what criteria and constraints effected farmer's decisions about using organic and/ or inorganic fertilizer in an environment shaped by structural adjustment policies. In 1998, it could not have come at a more appropriate time. Fertilizer verification field trials had just been completed throughout Malawi with the goal of recommending fertilizer application rates based on soil type. [34] However, the economics of the situation could not be ignored and in the final analysis, based on the ratio of fertilizer prices to maize prices, the "most profitable recommendation for farmers in most areas of Malawi was to apply no fertilizer to their hybrid maize." [35] The recommendation was not put forth without serious consideration for what that would mean for resource poor farmers. For the near future, the prognosis was "grim".

This research was conducted in the Zomba district of southern Malawi during the months of May and June of 1997 as part of the Gender and Soil Fertility Project though the University of Florida's Soils Management CRSP. Zomba's topography varies from mountainous and hilly regions, located between Machinga and Zomba district in the southern area, to broad, flat plains in the upper Shire River and east to Lake Chilwa. The diverse topographical characteristics cause a wide range of climate diversity. As a result, temperature difference and rainfall distribution may vary considerably between neighboring sub-districts, in effect, creating different climates for farmers separated by just a few kilometers. These variations and differences are important to keep in mind: Zomba's variations in climate, soil and topography make it difficult to speak of Zomba in a singular, unified way. For example, Mtubwi in the northern area of Zomba and in the upper Shire valley is at a much lower elevation than Malosa that borders on the south of Mtubwi district. Yet Mtubwi in the rain shadow of the mountains is much drier than its immediate neighbor to the south.

The sample covered 8 sub-districts. A total of sixty farmers were interviewed broken down into three sub-groups based on gender and marital status and comprised 16 men in male headed households (MHHs), 23 married female farmers (MF), and 21 female-headed households (FHHs). Within each sub-district, I interviewed 6 farmers, 2 farmers from each sub-group, if possible.

A comment on the categories of MHH, MF, and FHH is necessary. These were deliberately chosen in order to see if marital status had any affect on decisions concerning fertilizer and hybrid maize. I could have broken farmers down into just male and female but that would have "muddied the waters" particularly in regards to women's decisions in female-headed households. It is well recognized that the constraints FHHs face are much different than in MHH and they should be separated if the problem of household food security is to be properly addressed. Throughout the literature it is suggested that women in MHHs are more likely to concede to the husband for crucial decisions. Separation of married women (MF) from FHHs was done with the expectation that the married women's decisions, strongly influenced by their husbands, would closely resemble the decisions of male farmers [36] .

DECISION TREE MODELING

As the purpose of this research was to identify criteria and constraints facing farmers in Zomba in regard to use of inorganic fertilizer and planting hybrid or local maize, it seemed appropriate that decision tree modeling be used. The advantage of using decision tree models is that they are testable, cognitive models useful in describing specific criteria and constraints. [37] Decision trees are maps guiding the observer along the way as informants / experts go about choosing between a set of alternatives located at the top of the tree (denoted by { }). [38] The tree is composed of separate decision criteria (denoted by < >) that are arranged in a logical path that leads to a specific outcome (denoted by [ ]), e.g., [Use chemical fertilizer; don't]. Once constructed, the decision tree model can be tested for accuracy in prediction of the choices made by another sample of decision makers from the same group. [39] Should the prediction accuracy of the model be 85% or better, then it is judged to be an adequate model of individual decision processes of members of that group. [40]

The researcher may then identify the main factors limiting adoption or use of one of the alternatives, e.g., chemical fertilizer. These limiting factors are the criteria on the path leading to negative outcomes, e.g., [Don't use chemical fertilizer]. In this way, decision trees highlight criteria policy makers might use to encourage adoption of some intervention, e.g., fertilizer, by the target population. When results of testing a decision tree model are disaggregated by gender, as they are in this paper, then policy makers can clearly identify the main factors limiting adoption and use of the intervention by women as well as men. When results are disaggregated by marital status and gender, as they are here, then policy makers can see if there are more factors limiting adoption by FHHs than men and women in MHHs, or if some factors are more limiting to FHHs than to MHHs.

CONSTRAINTS TO USING CHEMICAL FERTILIZER

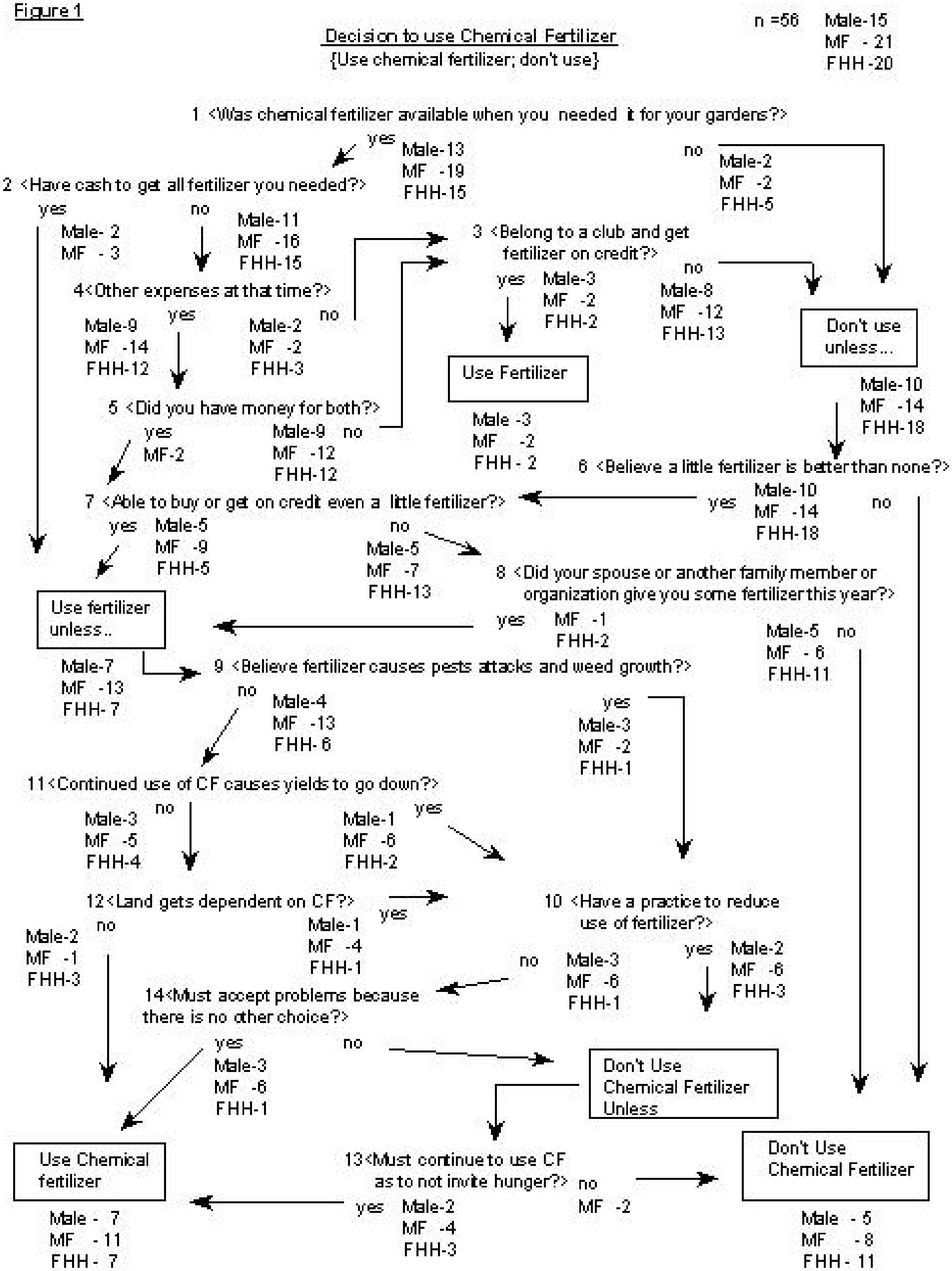
In the 1995/96 season, 80% of all informants used some chemical fertilizer on their maize. One year later, 1996/97, that number declined to 65% of all informants. The largest decline occurred within FHHs with a drop from 74% to 52% of all informants using some chemical fertilizer. Male informants (Male) and Married Female (MF) informants dropped 12% and 13% respectively. Over the same two seasons, there was a decline of 27% in the amount of fertilizer applied. The reasons most cited were the high price of fertilizer and the farmer's lack of cash. Not surprisingly, FHHs showed the greatest decrease in the amount used (34%). Married female informants reduced the amount used by 22% and male informants decreased the amount used by 26%.

As can be seen in Figure 1, for 89% of the informants, not having enough cash to obtain *all* the chemical fertilizer they needed was the main limiting factor (criterion 2). This is far from surprising in light of the rise in the price of fertilizer and the devastating effects devaluation of the Malawi Kwacha has had on most rural households. A very high percentage of male and married female farmers (87% and 86% respectively) did not have the cash to buy all the fertilizer they needed; while 100% of FHHs lacked the money to buy all the fertilizer they needed. Clearly, these figures suggest FHHs are "the poorest of the poor."

The importance of credit in the decision to use chemical fertilizer is evident from criterion 3 that separates the farmers who belong to farmers' clubs and get credit for fertilizer from those who don't; the former are sent to the outcome [Use fertilizer]. They are few, however. Criterion 6 confirms farmers' beliefs that chemical fertilizer is essential for good yields, while criterion 7 "cuts" farmers into those who are able to purchase or get credit for some fertilizer versus those who are not. In this case, it is the combination of marital status and gender that limits use of fertilizer: only 20% of FHHs were able to apply some fertilizer, compared to 50% of married women (MF) and 60% of male farmers (Male). Of those who could not apply some fertilizer, very few received free fertilizer from any source.

Of 13 FHHs who could not obtain some fertilizer, two (12%) received some fertilizer for free. One received it from her father because "she is a widow" and another received it from her mother. Of 7 married women, only one received free fertilizer, however, no male farmer received any fertilizer for free. Thus this decision tree suggests that three factors - lack of cash, not belonging to an active club and not having a source for free fertilizer - were the major reasons for keeping 55% of FHHs and 33% of married women and male farmers from using fertilizer.

Figure 1


Decision to use Chemical Fertilizer
{Use chemical fertilizer; don't use}
n =56 Male-15 MF - 21 FHH -20
1 <Was chemical fertilizer available when you needed it for your gardens?>
yes Male-13 MF -19 FHH-15
no Male-2 MF -2 FHH-5
2 <Have cash to get all fertilizer you needed?>
yes Male- 2 MF - 3
no Male-11 MF -16 FHH-15
3 <Belong to a club and get fertilizer on credit?>
yes Male-3 MF -2 FHH-2
no Male-8 MF -12 FHH-13
4<Other expenses at that time?>
yes Male-9 MF -14 FHH-12
no Male-2 MF -2 FHH-3
Use Fertilizer
Male -3 MF -2 FHH - 2
Don't use unless...
Male-10 MF -14 FHH-18
5 <Did you have money for both?>
yes MF-2
no Male-9 MF -12 FHH-12
6 <Believe a little fertilizer is better than none?>
yes Male-10 MF -14 FHH-18
no
7 <Able to buy or get on credit even a little fertilizer?>
yes Male-5 MF -9 FHH-5
no Male-5 MF -7 FHH-13
8 <Did your spouse or another family member or organization give you some fertilizer this year?>
yes MF -1 FHH-2
no Male-5 MF - 6 FHH-11
Use fertilizer unless..
Male-7 MF -13 FHH- 7
9 <Believe fertilizer causes pests attacks and weed growth?>
no Male-4 MF -13 FHH- 6
yes Male-3 MF -2 FHH-1
11<Continued use of CF causes yields to go down?>
no Male-3 MF -5 FHH-4
yes Male-1 MF -6 FHH-2
12<Land gets dependent on CF?>
no Male-2 MF -1 FHH-3
yes Male-1 MF -4 FHH-1
10 <Have a practice to reduce use of fertilizer?>
no Male-3 MF -6 FHH-1
yes Male-2 MF -6 FHH-3
14<Must accept problems because there is no other choice?>
yes Male-3 MF -6 FHH-1
no
Don't Use Chemical Fertilizer Unless
Use Chemical fertilizer
Male - 7 MF - 11 FHH - 7
13<Must continue to use CF as to not invite hunger?>
yes Male-2 MF -4 FHH-3
no MF -2
Don't Use Chemical Fertilizer
Male - 5 MF - 8 FHH - 11

Other criteria on the tree deserve attention. Some farmers have doubts about the continued use of fertilizer; some believe it causes pest attacks and weed growth (criterion 9). Others believe they must continue to use fertilizer, once they start, because the land gets dependent on chemical fertilizer (criterion 12). If they don't continue to use it, their yields might go down (criterion 11). Some farmers thus develop strategies or practices to reduce their fertilizer use (e.g., complementary use of manures, legumes, crop rotations) (criterion 10); farmers without such a practice feel they must continue its use so as not to "invite hunger" (criterion 13). Even though 21 of 28 (75%) farmers feel chemical fertilizer has its drawbacks, and just over half of this group know of a practice that could reduce the use of chemical fertilizer, 82% believe chemical fertilizer forestalls hunger. The 48% of farmers who do not have a practice to reduce their fertilizer use believe they have no other choice but to use chemical fertilizer (criterion 14).

This belief should not be underestimated as it has important implications for researchers trying to develop substitutes for chemical fertilizer. Organic alternatives to chemical fertilizer are available in the form of intercropping with grain legumes, adopting agroforestry innovations, and using animal manures. But few farmers are doing any of these *as a replacement for inorganic fertilizer*. This research shows that farmers desire chemical fertilizer because they see it as the best defense against a poor harvest. It also shows that few, if any, have access to enough animal manure to make a difference. Finally, the research shows that farmers are intercropping with grain legumes. What needs to be asked is whether they are improving the soil fertility with the grain legumes to such a degree that they do not need as much or even any chemical fertilizer. Intuitively, it would seem that the extensive intercropping of grain legumes over the years would have increased soil fertility to such a level that two things would be occurring simultaneously: an increase in maize yields along with a decrease in the need for chemical fertilizer. Because that is not happening, we need to investigate the reasons why.

As shown in the paper by Gladwin, Peterson, and Uttaro in this special issue, most Zomba farmers either lack knowledge of trees and shrubs that might improve their soil; or being aware of their imputed benefits, fully understand the management of them. Large amounts of time, effort and money have been invested in discovering ways to improve Malawi's soil fertility with green manures and other new soil improvement technologies. Over time this research should disseminate out to farmers throughout Malawi and it is hoped that Malawi's rate of declining soil fertility will slow down and even be reversed.

There are reasons to be concerned that even if the research is disseminated throughout the country, it may not have as great an effect as initially hoped. One of several factors is farmer practice and management of green manures that, in spite of research efforts, will mean a future where the majority of farmers in Malawi continue to experience declining soil fertility and increasing food insecurity. It is vital to understand what green manure is planted, why it is planted, and how it is managed and used in the garden. This is key and directly ties into whether chemical fertilizer remains a necessary input or not for adequate yields. If the green manure is used according to the protocols of the research, the need for chemical fertilizer should be greatly diminished, if not completely eliminated. Conversely, any deviation from the protocols that lessen its effect should correspond to a need for some chemical fertilizer.

Every farmer interviewed was intercropping the maize garden with crops such as pumpkin, pigeon pea, cowpea, and groundnuts. Grain legumes are the most prominent with pigeon pea ubiquitous throughout the Zomba RDP and all 60 farmers in my survey had it in their garden. A smaller yet substantial number (28 or 47%) planted mucuna. Although both mucuna and pigeon pea offer great potential as a green manure, the farmers are not treating them as such. The important question from a soil fertility perspective is how the farmer views a grain legume because that is going to determine how it is managed and ultimately whether it addresses soil fertility.

Research has shown mucuna and pigeon pea it to be beneficial intercrops and a significant number of surveyed farmers believe each is beneficial for their soil (Table 1 and Table 2 below). [41] However, according to agronomic research and personal interviews with agronomists, addition of enough nitrogen to significantly benefit the plants requires plant biomass to be turned under and incorporated into the soil before the pods and seeds form and mature - *a practice not a single informant in the survey engages in*. Timing, in this regard, is essential. After seed formation and the growing period, the plant virtually stops nitrogen fixation and transportation, concentrating nitrogen in the seeds while significantly reducing the amount of nitrogen in the leaves. [42]

Farmers in Zomba are intercropping primarily for food –not for soil improvement; a reasonable, rational and understandable purpose. Small land holdings combined with lower yields due to declining fertility places food as the first priority. In this sample of farmers, 95% rank pigeon pea as a food crop first (Table 1 below). The second priority is to sell the pea. Trailing far behind was the goal to improve the soil and of the 3% who ranked soil improvement as a first priority, not one turned the leaves under before seed formation. They even said that they like to eat and sell pigeon pea.

This should come as no surprise because pigeon pea is almost never used as a green manure crop (i.e. turned over before maturity). Other characteristics of pigeon pea, such as its slow initial growth and temporal complementarity with maize, make it an ideal intercrop to grow for seed. Additionally, the plant resembles more of a small tree than a short plant that would be easier to incorporate. One should therefore not expect any survey informants to turn pigeon pea under while green.

That being said, by treating pigeon pea as a food/cash crop, farmers are removing most of the nitrogen in the seedpod. Any senescing leaves that are brown contain much less nitrogen. Unless the farmer returns to the field and incorporates the dry leaves into the soil they remain on the soil surface throughout the dry season. [43]

Table 1: Farmers Ranking of Reasons for Planting Pigeon Pea

n = 60 % in ( )	Believe PP Improves Soil	Plant Pigeon Pea	Prioritize Plant to Eat			Prioritize Plant to Sell			Prioritize Plant to Improve Soil		
			1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Male	15	16	14	2	0	1	9	0	1	4	9

n=16	(94)	(100)	(87)	(13)		(6)	(56)		(6)	(25)	(56)
Married Female n=23	18 (78)	23 (100)	23 (100)	0	0	0	17 (74)	2 (13)	0	5 (22)	13 (56)
Female Headed Household n=21	15 (71)	21 (100)	20 (95)	1 (5)	0	0	15 (71)	4 (19)	1 (5)	5 (24)	12 (57)
All	48 (80)	60 (100)	57 (95)	3 (5)	0	1 (2)	41 (68)	6 (10)	2 (3)	9 15)	34 (57)

Mucuna, on the other hand, is a legume species better suited for green manuring and therefore, how the farmers view it will be more revealing. Mucuna is not as popular as pigeon pea and those who did not grow it cited its tendency to "take up too much room" and that it "creeps" as the main reasons for not planting it. These farmers feel mucuna is not an easy plant to manage and threatens any maize in the immediate vicinity. Even so, 77% of all farmers believe mucuna improves the soil (Table 2).

Slightly less than half of those interviewed (47%) planted mucuna, feeling that the benefits of mucuna outweighed the negatives. But soil fertility is not the primary reason why they plant it. It is not even the second reason. Like pigeon pea, 82% of the farmers who planted mucuna planted it as a food crop first. To sell was ranked second by 18% and only one farmer gave soil improvement first priority. Interestingly, when asked if he liked to eat or sell the beans, he said yes.

Table 2: Farmers Ranking of Reasons for Planting Mucuna

n= 60 % in ( )	Believe Mucuna Improves Soil	Plant Mucuna	Prioritize Plant to Eat (% of those who planted)			Prioritize Plant to Sell (% of those who planted)			Prioritize Plant to Improve Soil (% of those who planted)		
			1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Male	13	9	8	1	0	0	4	3	1	3	4

n=16	(81)	(56)	(89)	(11)			(44)	(33)	(11)	(33)	(44)
Married Female n=23	20 (87)	10 (43)	10 (100)	0	0	0	8 (80)	1 (10)	0	2 (20)	8 (80)
Female Headed Household n=21	13 (62)	9 (43)	5 (55)	4 (44)	0	5 (55)	4 (44)	1 (11)	0	1 (11)	7 (77)
All n=60	46 (77)	28 (47)	23 (82)	5 (18)	0	5 (18)	16 (57)	5 (18)	1 (4)	6 (21)	19 (68)

The same practices emerge with mucuna as with pigeon pea. When asked if they incorporate the leaves into the soil while still green and before the seed pod forms, not one farmer answered yes. Mucuna is grown for seed and as such, it is treated as primarily a food crop. Farmers are removing the seeds form the fields leaving the dry leaves on the soil surface.

Research has shown that leaf residue adds nutrients as well as biomass to the soil. The question is whether it is enough to compensate for the nutrients taken up by the following maize crop. Does the leaf residue create a net gain of nitrogen in the soil? Or is the outcome less optimal by simply restoring nutrients that would occur without legume intercropping? Again, this depends on what the farmer does. How the residue is managed determines its soil fertility benefit. For example, incorporating the dry leaves of pigeon pea by themselves will lead to a small net increase in soil nitrogen (1-2% N) in the short term. However, should farmers turn the leaves into the new ridges with the maize stover, then the stover binds the nitrogen, resulting in no nitrogen benefit for the following maize crop [44]. Unfortunately, this is a very common practice in Malawi.

An even more serious threat is the widespread practice of burning to clear fields during the dry season. In this case any nitrogen remaining in the dry leaves is lost in the fire. From a soil fertility standpoint, this practice is devastating. Since land is scarce in southern Malawi, gardens tend to border each other. When burning takes place the fire usually spreads to other farmer's gardens thus denying them of any benefits from the leaf residue.

It is risky to assume that intercropping maize with a grain legume will eventually lead to a greater soil fertility reducing the need for fertilizer. Under sowing dry leaves with the stover and/or clearing the land with fire are two very common practices that seriously jeopardizes the benefits obtained from growing pigeon pea as a food crop. Even the assumption that dry leaves add biomass to the soil is highly questionable in fields cleared with fire.

If farmers choose to plant a green manure as a food source, it will be managed in a way that truncates its imputed potentiality. Moreover, what farmers do after harvesting the seed will further effect soil fertility and that in turn dictates whether chemical fertilizer is needed and how much. These practices directly influence the length of a household's hunger season. Planting legumes for food addresses an immediate concern. Planting a legume as a green manure to improve soil fertility for the next year's harvest addresses a more distant concern. Prolonging hunger now is not an option.

In light of these challenges, the need for chemical fertilizer remains high in Malawi. Of the 60 informants, 57 believe chemical fertilizer as indispensable for improved yields, whether they are currently using it or not. Without it, they feel they are "inviting" hunger. Of all 60 informants, 54 (84%) believed they must use chemical fertilizer in order avoid hunger, regardless of any problems they identify with it. [45]

THE DECISION TO USE SMALL BAGS OF FERTILIZER

Clearly, chemical fertilizer is highly desired by farmers in Zomba. However, only a few farmers are able to purchase the amount of chemical fertilizer they think is necessary for optimal yields. The steep rise in the price of chemical fertilizer is attributed to the removal of fertilizer subsidies and even more so, the devaluation of the kwacha over the last five years. More and more farmers are finding that the cost of a 50 kg bag of chemical fertilizer is simply out of their reach. Asked if even a little fertilizer was better than no fertilizer at all, it was not surprising that every informant answered yes. The next best scenario then would be obtaining less than adequate amounts of fertilizer.

One innovation that was being introduced at the time in some parts of Malawi is repackaging fertilizer in smaller quantities than 50 kg bags. For example, in Dowa, in the central region of Malawi, VEZA/HODEZA offers fertilizer in smaller than 50 kg bags. Small bags of fertilizer, it was hoped, would provide some fertilizer to poor farmers whose purchasing power had been drastically eroded. Farmers who do not have the cash for a 50 kg bag might purchase a smaller quantity of fertilizer – a quantity they could afford. [46]

Moreover, it is anticipated that the use of small bags of fertilizer by FHHs would be one way to improve food production on their very small landholdings. Cash was the main constraint stated by all farmers who do not apply any fertilizer or manure on their maize

(n = 18). But when asked if they had the cash for at least a small bag of fertilizer, although eight farmers said yes (44%) the result is less encouraging for FHH. At issue is whether or not poorer FHHs would be able to afford even a small bag of fertilizer. Table 3 shows that seven out of 10 FHHs not using fertilizer or manure now say they would also not be able to afford a small bag of fertilizer. (These results are replicated by D'Arcy in Dowa, central Malawi. [47])

Table 3: Number of Farmers Not Using Any Fertilizer or Manure Likely to Buy Small Bags

Have Cash For Small Bag of Fertilizer?	Yes	No
Male (n=4)	2	2
Married Female (n=4)	3	1
FHH (n=10)	3	7

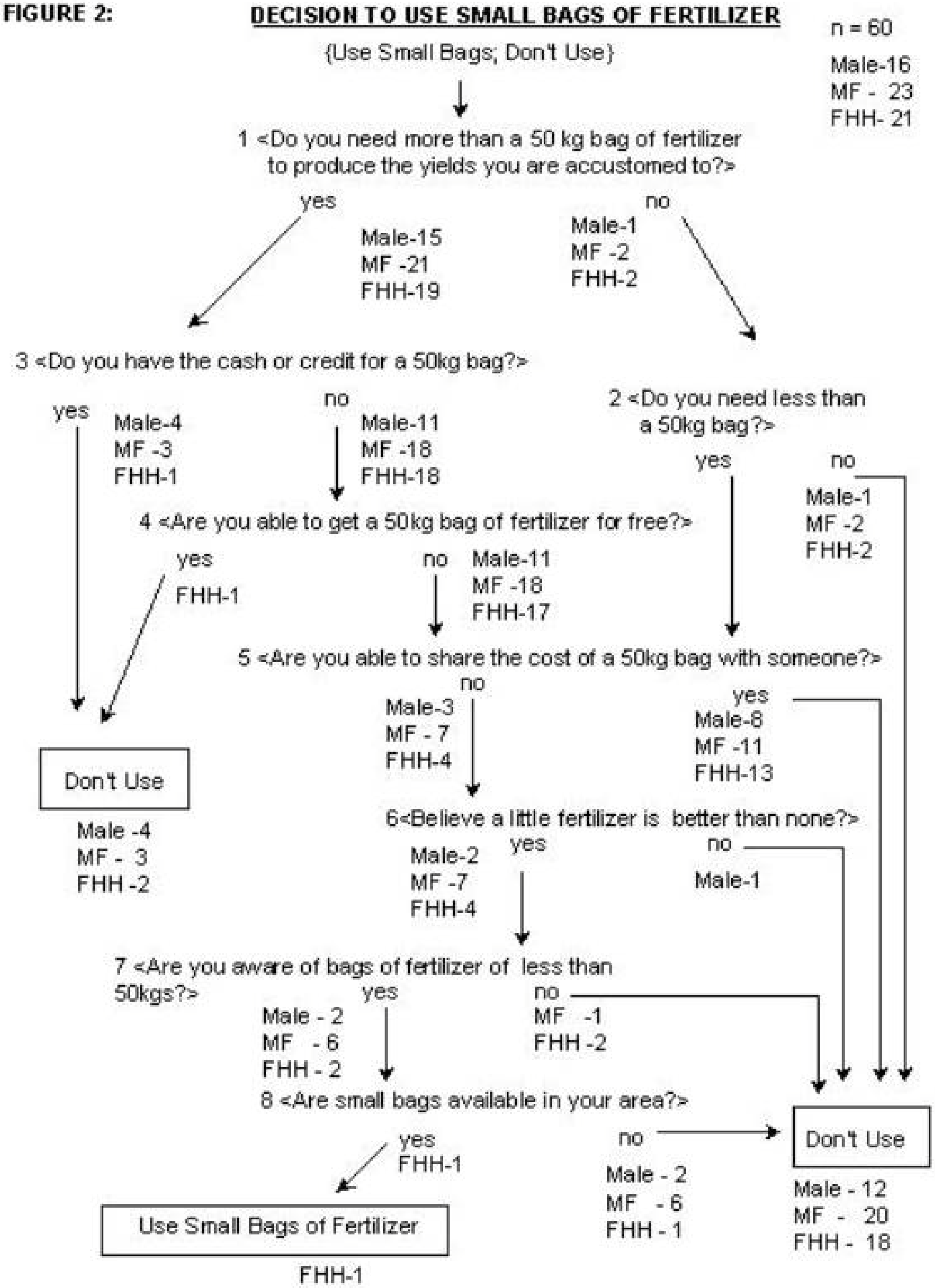
All (n=18)	8	10

The second concern hoped to address matters of weight and transport, particularly important for FHHs. Transporting fertilizer is a factor in its use and smaller bags would be easier to carry, not only from the store or club, but also to the field. [48] It was argued that lighter weights would not only be an incentive to buy the smaller bags of fertilizer but for some farmers whose health is deteriorating - and in Malawi, there are many farmers in poor health - it may be one of the more important ones. However, the problem of FHHs not having available cash for small bags lessens the saliency of the benefit of smaller weight for them.

Other issues surface in the model of the decision to use small bags of fertilizer, seen in figure 2, which lists reasons why almost all (59 of 60) informants choose not to use small bags of fertilizer. Only one informant is able to continue to stage-2 criteria, for brevity not presented here. [49] Criteria in figure 2 say that farmers will switch to smaller bags of fertilizer if they need more than a 50 kg bag for their crops and cannot afford to buy another one (criteria 1,3), or they need less than 50 kg and cannot afford to buy even one 50-kg bag (criteria 2), or (and this is true for the majority) they are not able to share or split a 50 kg bag with someone (criterion 5).

Surprisingly, a large percentage of farmers (70%) responded positively when asked if they can share the cost of a 50 kg bag of fertilizer with family, friends, or neighbors. Indeed, if this is the case, then the ability to share a 50 kg bag is a significant factor limiting the demand and use of smaller bags, which are more expensive per kilogram of fertilizer received. However, the way the criterion was phrased might have been misleading. To ask "Are you able to share the cost?" is not the same as asking "Do you share the cost of a bag?" The phrasing of the question is unclear such that responses are ambiguous.

FIGURE 2: **DECISION TO USE SMALL BAGS OF FERTILIZER**



Unfortunately, there simply are not enough data here to support the conclusion that farmers are sharing the cost of 50-kg bags of fertilizer with family and neighbors. Out of 60 informants, only five (8%) specifically mentioned that they either received fertilizer from a family member or gave some to a family member. Only one informant said she was sharing the cost of a bag with a neighbor. Other data seems to speak against current sharing. Within the last three years, fourteen farmers (23%) were using fertilizer and stopped due to its high cost. Not one of these informants is now receiving fertilizer from a family member, friend or neighbor; yet 11 of the 14 said they could share the cost of a bag with someone.

The option of farmers' obtaining fertilizer repackaged in a small bag does not look promising. There are two obstacles - one serious - inhibiting the use of small bags. First, the less serious obstacle is availability. During the 1996/97 growing season finding small bags of fertilizer in Zomba was difficult. In fact, they were almost non-existent. There was, however, a noticeable increase in availability of small bags in the 1997/98 season in major market centers such as Mayaka, Jali, and urban centers of Blantyre, Lilongwe and Zomba. Managers in a few other market centers informed me that they expected to have smaller bags of fertilizer arriving before planting season. In smaller trading centers and other rural centers small bags remained unavailable. Nevertheless, fertilizer in small bags was appearing in places where they were absent the year before.

A greater obstacle to obtaining fertilizer in small bags is the higher price per kg of the smaller bags. In 1998, in those markets where small bags of fertilizer were available, they were not selling. Researching this phenomena, additional explanations offered by farmers were discovered including the persistent lack of money, cost of small bags, transport costs incurred traveling to a market center to buy a small bag and that smaller bags had a the higher cost per kg. If there was no economic justification for using fertilizer on maize at the price of a 50 kg bag, it was an even more compelling reason not to use it in a 5 – 10 – or 25 kg bag. [50] These last two reasons introduced additional constraints in the decision to use small bags of fertilizer that were unfortunately not included in the decision tree and unforeseen by policy planners when repackaging fertilizer in small bags was being developed.

In sum, it seems unlikely that small bags of fertilizer will contribute to any lessening of food shortages at the household level, at least not until small bags become more available and the price per kg becomes more reasonable. In the interim, more research needs to be done on increasing access to small quantities of fertilizer. [51] Even if small bags of fertilizer become available, this research suggests that household incomes need to increase for a significant proportion of these farmers to afford even the small bags.

It also appears unlikely that sharing a 50 kg bag is a solution, at least at the moment. This option may be constrained by lack of trust between neighbors and friends who would be expected to share 50-kg bags, as social capital, ravaged during the later half of the Banda years, has further declined in the post-structural adjustment era.

THE DECISION TO PLANT HYBRID MAIZE

One of the most important decisions farmers have to make is whether to plant hybrid maize versus local maize, or both. Hybrid maize is well received by farmers because it addresses both food security and cash needs of the household economy. It addresses food security in two highly significant ways: higher yields and early maturation. Considerably higher yields come with a cost, as expensive inorganic fertilizer has to be applied. In some situations, due to soil and climatic conditions, hybrid yields may not be any larger than local maize particularly if unfertilized. Around Nsanje, for example, in the lower Shire Valley, fertilizer is not used. In a nationwide survey carried out in 1997/98, a random sample of fifty farmers in twelve villages in the lower Shire showed that not one respondent used inorganic fertilizer. The reason consistently stated is the soil's natural fertility due to the almost annually flooding when the Shire River overflows its banks leaving behind nutrient rich silt. It is the river's parting gift, compensation for causing harm and ruin to so many homes.

The soils in Zomba are not revitalized as in the Lower Shire. The soils of the farmers surveyed require amendments to boost yields adequately. As the discussion above regarding the decision to use inorganic fertilizer shows, the farmers in this survey feel that inorganic fertilizer is vital to averting the hungry season. [52] The relationship between fertilizer use and hybrid yields is also convincing. Asked to choose between animal manure and chemical fertilizer, fertilizer was overwhelmingly preferred for higher yields (Table 4).

Table 4: Farmers choice between animal manure and chemical fertilizer for best hybrid yields

What do you think will cause your hybrid maize to have the best yields: animal manure, chemical fertilizer or both?			
Respondents n=60	Animal Manure	Chemical Fertilizer	Both
Male n=16	1 6%	14 88%	1 6%
Married Female n=23	1 4%	22 96%	0
Female Headed Household n=21	1 5%	18 85%	2 10%

Early maturity is the other attribute that makes hybrid maize preferable over local maize. Malawi's rainfall has been erratic during the last decade and climatic change has affected the timing and duration of the rainy season. Rainy seasons ending prematurely causes local maize to dry up in the fields before ears have formed spelling doom to a family relying on it. Smallholder farmers cannot risk the household food supply on local maize just because they prefer its taste, or pounds better or even stores better. The vast majority of farmers view the earlier maturing hybrid as an important defense against hunger. They may see hybrid maize, with all its constraints, as one of the best strategies to employ in order to greatly minimize the risk associated with local maize. Even in the fertile lower Shire, hybrid is overwhelmingly desired for this reason.

The decision tree shows a complex web of factors that lead farmers to choose one of two outcomes, [Plant hybrid maize] or [Plant local maize] (figure 3). Access and availability of inorganic fertilizer is one of several pivotal factors influencing that choice. The others that carry much weight with farmers are access to seed and fear of crop loss with local maize.

The criteria and constraints identified by respondents came from four varieties of hybrid maize, which they had experience with: MH – 17 and18 and NSCM – 41and 51. Of the 29 farmers who planted hybrid in 1996/97, only 7 planted NSCM – 41, the rest planted either MH-17 or MH-18. At the time of this research, there were other varieties of semi-flints being introduced that addressed some of the constraints identified by farmers but only one farmer – a male who was educated through Form 2 and had a junior certificate – mentioned one of the new semi flints (Chitute) in the survey. Even so, he planted MH-18 and NSCM-41. It is possible the new semi flints were known but not available in the stores. It is also possible that knowledge of these new varieties was very limited at the time. As these new varieties become known, some of the constraints they were developed to address such as storage difficulties will disappear. Other constraints, such as price of seed, are less likely to change.

At the top of the tree in figure 3 are criteria asking whether hybrid maize tastes better than local (criterion 1), pounds better (criterion 2) and/or yields better (criterion 3). Eighteen percent of all informants believe hybrid maize tastes better than local maize and of those 91% prefer local because it pounds better. Although 86% believe hybrid has higher yields and 74% believe it is easier to sell than local maize (criterion 5), hybrid does not store well (criterion 4) –t he greatest constraint to planting hybrid maize at this point of the decision tree. Of those who believed hybrid has better yields, 93% stated that it does not store as well as local. (One informant lost her entire hybrid harvest to weevils the year before.) All other things being equal, the storage constraint alone would account for a large number of farmers not planting hybrid.

Nevertheless, farmers who plant hybrid maize do so for two good reasons. The first is to sell it for income. Seventy four percent believe hybrid is easier to sell than local. Hybrid's earlier maturity and greater yields provide the family with a welcome opportunity to gain access to cash. The second reason is to shorten the hungry season. Both are compellingly sound reasons to grow hybrid maize.

There is a problem that surrounds the income decision and it is as much a result of the disadvantaged situation farmers are in as it is with hybrid's storage problem. Because farmers believe that hybrid does not store well and due to their usually cash strapped circumstances, they tend to supply the market at the same time, depressing prices in the process. The little cash they receive cannot, under current price ratio, pay for production cost of fertilized hybrid and is far less than what they will be paying for maize during the hunger season. This is an ongoing scenario repeated every year representing another diminishing choice to poor households in need of an immediate influx of cash. [53]

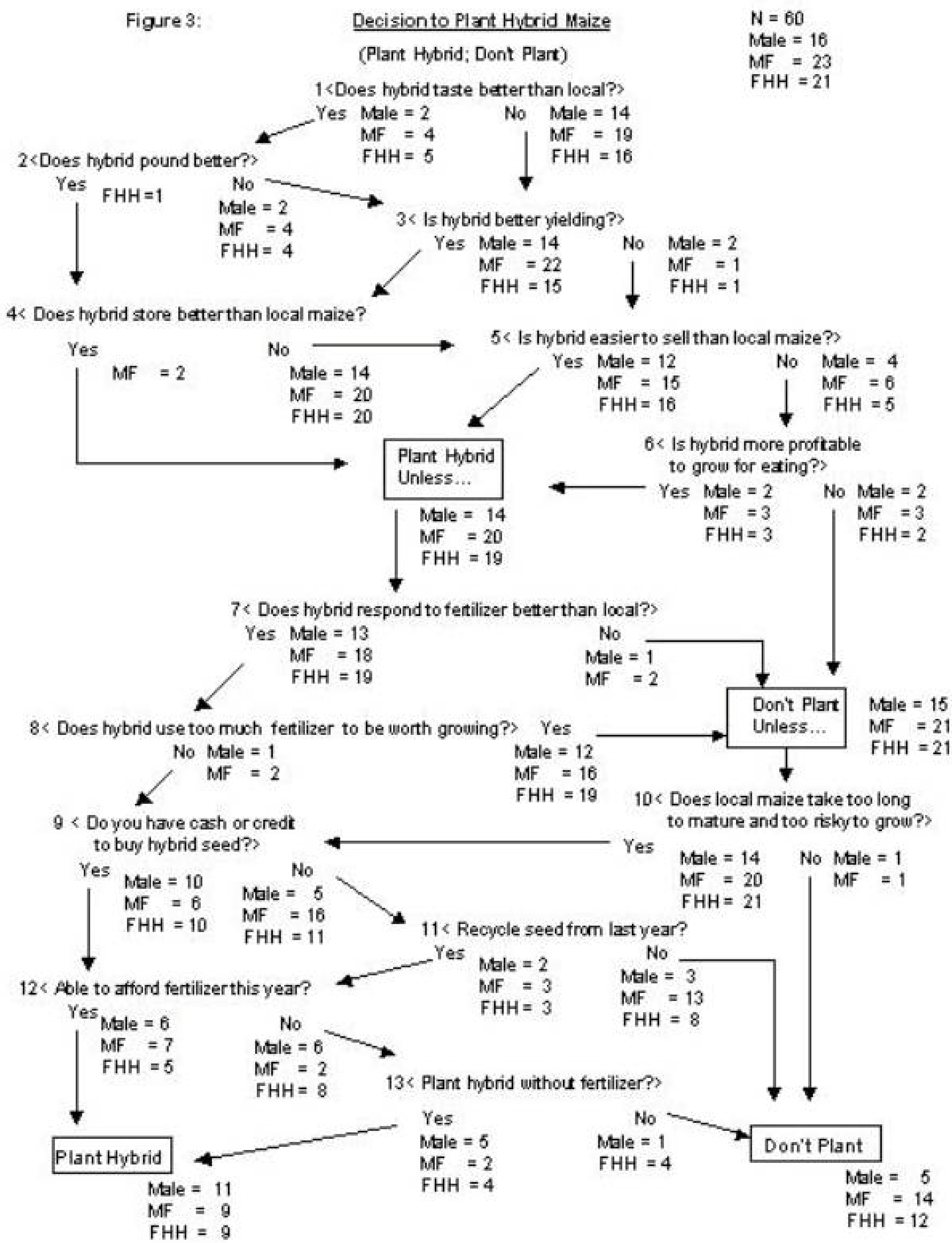


Figure 3:
Decision to Plant Hybrid Maize
(Plant Hybrid; Don't Plant)
N = 60
Male = 16
MF = 23
FHH = 21
1<Does hybrid taste better than local?>
Yes Male = 2
MF = 4
FHH = 5
No Male = 14
MF = 19
FHH = 16
2<Does hybrid pound better?>
Yes
FHH =1
No
Male = 2
MF = 4
FHH = 4
3< Is hybrid better yielding?>
Yes Male = 14
MF = 22
FHH = 15
No Male = 2
MF = 1
FHH = 1
4< Does hybrid store better than local maize?
Yes
MF = 2
No
Male = 14
MF = 20
FHH = 20
5< Is hybrid easier to sell than local maize?>
Yes Male = 12
MF = 15
FHH = 16
No Male = 4
MF = 6
FHH = 5
Plant Hybrid Unless...
Male = 14
MF = 20
FHH = 19
6< Is hybrid more profitable to grow for eating?>
Yes Male = 2
MF = 3
FHH = 3
No Male = 2
MF = 3
FHH = 2
7< Does hybrid respond to fertilizer better than local?>
Yes Male = 13
MF = 18
FHH = 19
No
Male = 1
MF = 2
Don't Plant Unless...
Male = 15
MF = 21
FHH = 21
8< Does hybrid use too much fertilizer to be worth growing?>
Yes
Male = 12
MF = 16
FHH = 19
No Male = 1
MF = 2
10< Does local maize take too long to mature and too risky to grow?>
Yes
Male = 14
MF = 20
FHH = 21
No Male = 1
MF = 1
9 < Do you have cash or credit to buy hybrid seed?>
Yes
Male = 10
MF = 6
FHH = 10
No
Male = 5
MF = 16
FHH = 11
11< Recycle seed from last year?
Yes
Male = 2
MF = 3
FHH = 3
No
Male = 3
MF = 13
FHH = 8
12< Able to afford fertilizer this year?
Yes
Male = 6
MF = 7
FHH = 5
No
Male = 6
MF = 2
FHH = 8
13< Plant hybrid without fertilizer?>
Yes
Male = 5
MF = 2
FHH = 4
No
Male = 1
FHH = 4
Plant Hybrid
Male = 11
MF = 9
FHH = 9
Don't Plant
Male = 5
MF = 14
FHH = 12

Other criteria further down the tree appear to support farmers' preferences for local maize. The belief that hybrid uses too much fertilizer to be worth growing is supported by an overwhelming 93% of respondents (criterion 8) . In light of this research, this would appear to be a constraint that would sound the death knell for planting hybrid maize. However, as substantial as this constraint is, any negatives associated with hybrid maize are far outweighed by one negative fact concerning local maize: local maize takes too long to mature. When asked if local maize is therefore too risky to grow, 96% farmers agreed - strong evidence that the risk associated with local maize is too high to plant only local maize.

Even if it needs fertilizer, planting hybrid offers a strategy to farmers to mitigate the risks associated with local maize and its longer growing season. Hybrid maize seed was developed and marketed for exactly that reason. Its early maturity and greater yields means that farmers, particularly those with small land holdings, are able to improve household food security. The benefits of increased yields come with a price, however, and that price is fertilizer.

The high price of fertilizer is not the only constraint to planting hybrid. The price of hybrid seed also represents a serious constraint to farmers. As the tree shows, farmers prefer hybrid even after saying it uses too much fertilizer to be worth growing due to the risks associated with growing only local maize. The price of the seed, however, is a constraint to 55% of the respondents (criterion 9) but represents less of a constraint to male farmers (66% can afford the seed) whereas 55% of FHH and 72% of married women cannot. There is, however, an alternative and that is to plant recycled seed (criterion 11) but only 25% have the opportunity; the others have no choice but to plant only local maize, assuming all the inherent risks. Again women farmers, whether in FHH (73%) or in male headed households (81%), are less likely to have access to even recycled seeds than male farmers (60%).

In the end, 53% are able to afford fertilizer for hybrid (criterion 12). For the others who cannot afford fertilizer, 69% will plant hybrid unfertilized (criterion 13) rather than plant just local, clearly demonstrating their fear of the risks to their households if they do not plant some hybrid maize.

From a gender perspective, it is clear that women in FHHs and in MHHs are feeling the constraints of fertilizer and seed prices more than men. In previous constraints, all three sub-groups show little difference in preferences and beliefs. Yet separation between the genders begins at the cash-for-seed criterion and continues with criteria further down the tree. In the end, 69% of male farmers are able to plant hybrid maize but only 39% married women and 43% of FHH can.

The decision tree tells only part of the story. Even as hybrid maize greatly reduces the risks of a long hungry season, fewer hectares were being planted with hybrid and more with local as a result of less farmers planting hybrid maize (Table 5).

Table 5: Number and Percent of Farmers Who Planted Hybrid Maize.

	1995/96	Percent	1996/97	Percent	Percent Change
ALL	40	67	29	48	- 19

n=60					
Male N=16	13	81	11	69	- 12
Married Female N=23	12	52	9	39	- 13
FHH N=21	15	71	9	43	- 28

These numbers contrast with earlier research that found the acceptance of hybrid maize among smallholder farmers, particularly women, as problematic. [54] The percentage of farmers growing hybrid prior to 1996/97 contradicts any notion of acceptance being problematic. Farmers in the survey are fully aware of the benefits of hybrid in spite of personal preferences towards local in areas such as taste, pounding and even the critical shortcoming of hybrids notorious storage problem. Evidently these preferences pale in comparison to the two main benefits of early maturity and higher yields that farmers view as critical for addressing food security. The decline in planting hybrid is better explained by other factors, namely the increased price of fertilizer and hybrid maize seed.

According to farmer responses in the questionnaire, 19% fewer farmers planted hybrid maize in 1996/97 than the previous year with the largest percentage drop occurring with FHH. 34% of those who planted hybrid in 1996/97 did not use fertilizer compared to 30% in the previous year. Overall, 1996/97 saw a drop of 11% of farmers planting fertilized hybrid compared to the previous year (Table 6). Breaking it down further, 29% of FHH, 38% of male farmers and 30% of married women used fertilizer on their hybrid in 1996/97 compared to 43% FHH, 50% male and 39% married women the year before. With the price of seed a major constraint to farmers, it would not make sense to spend scarce cash on hybrid seed and then not fertilize it particularly when, unfertilized, the yield of hybrid is not much different than that of local.

Table 6: Change in Number and Percentage of Farmers Who Planted Fertilized Hybrid Maize

	1995/96	Percent	1996/97	Percent	Percent Change
All n=60	26	43	19	32	- 11
Male	8	50	6	38	- 12

n=16					
Married Female n=23	9	39	7	30	- 9
FHH n=21	9	43	6	29	- 14

One explanation might be the fact that under certain climatic and soil conditions, unfertilized hybrid still has a better response than local maize. Since this research took place in Zomba, it is likely that the variations in climate conditions were not that great. Regarding variations in soil conditions, that unfortunately remains a question that this research was not capable of determining. It remains a possibility that some farmers who did not fertilize their hybrid, have better soil conditions. However, relying on data provided by farmers and mentioned above, it seems safe to assume variations in soil conditions is not that wide. Considering that this group of respondents overwhelmingly felt that their soil needed fertilizer, planting unfertilized hybrid would seem to be a waste of scarce money, unless the risks of planting only local are also considered. Examined under that light, planting unfertilized hybrid maize makes better sense, even with the lower yields. Not only is the number of farmers planting unfertilized hybrid increasing, the amount of fertilizer applied to hybrid is also decreasing as shown in Table 7 below.

Table 7: Change In Total Fertilizer In kgs Applied to Hybrid Maize by Farmers Who Planted Hybrid Both Years.

	Hybrid 95/96	Hybrid 96/97	Percent change
Male n = 11	755	450	- 40%
Married Female n = 9	1350	740	- 45%
FHH n = 9	1202	680	- 43%

Furthermore, the total amount of hectares planted in hybrid is declining as well as shown in Table 8. Here we see the most dramatic decrease is with FHH. In the course of one year, total hectares of hybrid maize planted by FHH in the Zomba RDP decreased by 57%. Male and Married Female farmers showed nearly similar decreases, with a decline of 20% and 23% respectively.

Table 8: Change in Hectares Planted with Hybrid

	Hybrid 95/96	Hybrid 96/97	Percent change
Male	7.22	5.8	-20
Married Female	10.92	8.42	-23
FHH	8.88	3.8	- 57

Conclusion

The focus of this paper was to analyze the criteria and constraints farmers, both women and men, use in making decisions that have a direct bearing upon household food security. With a gendered perspective, it makes the invisible woman visible, shedding light on those factors that affect her and her family's situation either positively or negatively. The series of figures in this paper show women farmers, whether as FHHs or women within male headed households, as well as men use decision processes to minimize the risks associated with local maize while trying to gain the benefits of hybrid maize in a larger environment of escalating fertilizer and seed prices.

Because other variables (i.e. weather, labor put into the gardens, pest attacks, etc) significantly affect yields, it is impossible to draw any solid conclusions about how the decisions made by the informants affected their yields. What can be said is that women farmers are making as complicated a set of decisions as men are – decisions that directly affect their household food security.

It also can be said that marital status of a woman does make a difference in terms of choices. As a group, married women are more likely to have access to some fertilizer than a FHH by a margin of 62% vs 45%. The variation between male farmers and married females is slight with 67% of male farmers able to afford some fertilizer. Moreover, even if the percentage of farmers that are able to pay for all the fertilizer they need is small (9%), marital status is a factor. No FHH was able to obtain all the fertilizer needed.

Other conclusions that can be drawn from the research is that the farmers in Zomba want fertilizer and in an overwhelming number. They have seen what results from not using fertilizer and fear that without it, they and their families will face hunger. Since 91% of farmers cannot acquire the amount they need, then the next best choice would be to acquire some amount of fertilizer. This research, however, also examines the potential impact of small bags of fertilizer, if they were to be freely available in local shops and markets. Results here describe why almost no one buys them now; while they also suggest that FHHs, who would benefit the most from their introduction, would probably not have the cash to buy them. Once again, gender and marital status make a difference. FHH are much less likely to obtain even smaller quantities of fertilizer, either with cash or credit, than married females or males. The bottom line is that 55% of FHH did not use any fertilizer on their crops compared to 38% of married females and 33% of male farmers.

The promise of using green manures to supplement or replace the need for inorganic fertilizer is unlikely. Survey respondents are not intercropping with legumes as green manures but with legumes as food and income crops. In this statistical sample, it is universal. Moreover, farmer practices of undersowing the dry leaves with the maize stover or clearing fields with fire are greatly reducing any benefits from planting the legumes.

The decision tree model to plant hybrid maize shows that it is a complicated, *multi-dimensional* decision process involving farmer minimization of the risk of a short rainy season, providing an earlier source for income, and shortening the hungry season by yielding more and maturing earlier. These factors, however, need to be seen in relation to the risk-taking that planting local maize assumes. Planting local maize places the household at much greater risk in terms of food production. However, it requires little if any inputs and this saves the household money. Is it a trade off? Lower yields and no cash means the hungry season will start earlier and hurt much more. However, as this research shows, the advantages offered by hybrid maize are increasingly becoming out of reach for more farmers due to two constraints: the un-affordability of fertilizer and the un-affordability of seed. There is nothing new here and this evidence only corroborates earlier research [55] .

Further, the model clearly shows the linkage between fertilizer use and cultivation of hybrid maize is strong; but due to the multi-dimensionality of the decision, it alone does not explain why farmers prefer to plant hybrid maize. Interestingly, every farmer who had some cash or grant for fertilizer grew hybrid maize; but a significant proportion of farmers (47%) said even if they could not afford fertilizer for hybrid, they would plant hybrid maize, *if they could afford the seed*.

None of these developments bode well for Malawi. The upshot of all this is evident in the current tragedy the people of Malawi are facing. The harvest of 2002 has been dismal with a shortfall estimated to be around 600,000 metric tons. That is the amount Malawi will have to import in order to stave off the starvation seven million people face as their maize runs out. Although much of the suffering has been blamed on flooding followed by drought, that is misleading. It is true that the rainfall season was sporadic and there were floods in parts of the country. But the drought had a more devastating impact on local maize, which more Malawians planted.

"The weather part is very small, because the floods and dry spells were localized," says Ellard Malindi, Malawi's secretary for agriculture and irrigation. "Most of it was due to the lack of inputs [of fertilizer and seeds]." Corn production during that period, from 1998 to 2001, fell to 1.4 million metric tons from 2.4 million. [56]

The fact that farmers are planting less hybrid and more local maize has serious repercussions for household food security. In 2002, it was devastating. For farmers who do not grow a cash crop such as tobacco, it is particularly salient. For many households, particularly FHHs, it is more in the nature of a desperate measure because of diminishing choices.

Notes

1. Up until recent years, the corporation enjoyed a monopoly on the purchase of virtually all marketable peasant produce. It was established by the government to control prices on smallholder produce with the intent of raising revenue for the government. ADMARC would buy crops from the peasants at very low prices and sell them at higher prices on the world market to earn large profits. Between 1983 and 1987 profit margins on crop trading averaged 32 percent of net sales. In some years the profit margin has been as high as 42 percent. The rich farmers, on the other hand, never fell under the control of ADMARC. Instead, they had direct access to the world market through the auction floors. It was also the only institution that supplied inputs to peasant farmers. . In 1996, the government, under pressure to liberalize its economy, passed the Privatization Act, which was to divest the government of much of its assets and enhance the role of the private sector in agriculture. In accordance with the Privatization Act, the government prepared for the commercialization and privatization of ADMARC by end-March 1999, with implementation to begin not long after. By the start of the 1999/2000 crop season, the government was to be no longer be involved in direct procurement, import, or sale of maize, and ADMARC was to operate on purely commercial terms. However, by 1998, it was clear that the government and ADMARC were dragging their feet on implementing the program resulting in much confusion. One result is that some ADMARCs in distant rural communities have virtually become non-entities, unable to purchase produce from farmers while the private traders have not shown up to replace ADMARC's presence. The upshot is that in many communities, smallholder farmers have no access to the market.
2. This year ADMARC failed to buy sizeable quantities of maize from the farmers resulting in low stocks. USAID lists three reasons for this failure: "(a) the general drop in maize production, resulting in a net maize deficit in the country; (b) its late entry into the maize market after the private traders had already bought most of the maize from the farmers; and (c) ADMARC's low producer price, only about half of what the private traders were offering." When ADMARC decided to adjust its purchase price upward it did so very late after the harvest. (USAID/FEWS NET Nov-Dec 2001Monthly Report). Also adding upward pressure on prices is the fact that the Government of Malawi (GOM) made a controversial decision to sell its strategic reserve of maize purportedly at the behest of the IMF in order to raise money for debt payment and government operation expenditures. The act itself appears to contradict the very purpose of the strategic grain reserve, which had government commitment to maintain it as a means to even out maize availability between years of drought. The IMF has denied advising the GOM or the National Food Reserve Agency to sell off the strategic maize reserve. It is not clear what happened to all the proceeds from the sale.
3. In 2001/02 the food security situation was estimated to be "tight" with possibilities of starvation reported in a number of districts especially in the South and Central regions.

In the north, the situation is slightly better as people with money are able to buy cheaper maize from local sources as well neighboring Tanzania. Severe flooding in parts of Malawi in the first half of 2001 exacerbated the situation (SADC Food Security Quarterly Bulletin, October, 2001). To add to the suffering, drought during the height of the growing season decimated crops in early 2002. Estimates range between 3 to 7 million people or more face starvation.

4. Owens, Patricia 1999. *When Maize and Tobacco are Not Enough: A Church Study of Malawi's Agro-Economy*. 2nd Edition. Peggy Owens, ed. CLAIM, Blantyre. P.20
5. International Food Policy Research Institute. 1997. "Food Gap Widening in Developing Countries: One in Four Children Worldwide Will Be Malnourished in 2020".
6. Since the mid-1990s, fertilizer prices have risen sharply while a series of currency devaluations and high inflation rates have severely eroded household purchasing power. The upshot being that most smallholder farmers have been unable to afford adequate amounts of fertilizer, if any at all.
7. Reports are coming out placing a share of the blame for the potential famine Malawi is facing on the decline in the use of fertilizer on hybrid maize and the decline in the planting of hybrid. It is believed that the drought would have been less severe if fertilizer and hybrid seed were made available to all Malawi's smallholder farmers this past year as the Starter Pack Program did in the previous three years. See "Man-Made Food Crisis Grips Southern Africa" Christian Science Monitor, May 15, 2002.
8. Gladwin, Christina, Anne M. Thomson, Jennifer S. Peterson, and Andrea S. Anderson. 1998. "Addressing Food Security In Africa Via Multiple Livelihood Strategies Of Women Farmers" p.2.
9. Shapouri and Rosen, 1999, p.1
10. ibid.
11. It is estimated that in Malawi, 65% of the population lives below the poverty line and on less than $2 per day or MK134 (USAID/FEWS, 2001). Using the current ADMARC official price for maize at MK17 per kg (and not the market price of MK25 per kg, an increase in production of just three bags of maize would have a value of MK2550 for the household. Of course, how the increase in production comes about is not addressed in this calculation. At the time of the research, using inorganic fertilizer on hybrid maize was not recommended due to the high producer fertilizer to maize price ratio. However, at current prices, it may beginning to make sense to use fertilizer on maize.
12. Staatz, J., 1990. "Food Security and Agricultural Policy" in T.R. Frankenberger et al. Proceedings of the Agricultural-Nutrition Linkage Workshop, Volume I, USAID, Arlington.
13. World Bank. 1990. *Symposium on Household Food Security and the Role of Women.* Harare, January 21-24, 1990.
14. Gladwin, Christina,et al. 2001. "Addressing Food Security In Africa Via Multiple Livelihood Strategies Of Women Farmers" Adedeji, Adebayo, 1989. "Interaction Between Structuralism, Structural Adjustment and Food Security Policies in Development Policy Management", ECDPM Occasional Paper, Maastricht. Von Braun.

1991. "A Policy Agenda for Famine Prevention in Africa" Food Policy Report, International Food Policy Research Institute.

15. In 1985, food security was defined as access by all people at all times to sufficient food, in terms of quality, quantity and diversity, for an active and healthy life without risk of loss of such access. See Reutlinger, S. 1985. "Food Security and Poverty in LDCs" Finance and Development, vol. 22, no. 4, pp 7 – 11. ; United Nations, 1988. Towards Sustainable Food Security: Critical Issues, Report by the Secretariat, World Food Council, Fourteenth Ministerial Session, Nicosia, Cyprus, 23 – 26 May.; World Bank, 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*, World Bank Policy Study, Washington, D.C.
16. World Bank/World Food Program.1991 *Food Aid in Africa: An Agenda for the 1990s* p.14.
17. UNICEF, 1990. "Strategy for Improved Nutrition of Children and Women in Developing Countries", UNICEF Policy Review, New York P.2. Alamgir, Mohiuddin and Arora, Poonam. 1991 *Providing Food Security For All* London: International Fund for Agricultural Development (IFAD)/Intermediate Technology Press.
18. UNICEF, Namibia, 1991. *A Situation Analysis of Children and Women in Namibia*. UNICEF, Namibia.
19. Gladwin, et al. 2001 argues that simply increasing production of subsistence crops may be ineffective. Current thinking about food security, that it is an issue of household income and poverty and not just inadequate aggregate food production, challenges programs which encourage women to just grow more food crops to improve their food security. Instead, government should look for ways to improve returns to farmers' resources in a broader context, which may include expanded opportunities for non-farm micro enterprises and agricultural labor. See Gladwin, Christina,et al. 1998. "Addressing Food Security In Africa Via Multiple Livelihood Strategies Of Women Farmers", and Subcommittee on Nutrition of the United Nations/International Food Policy Research Institute (SCN/IFPRI). 1999. Fourth Report on the World Nutrition Situation. SCN/IFPRI, Washington, D.C.
20. Unfortunately, they typically sell it when the market price is lowest reaping a much smaller benefit then if they waited until demand spiked the price upwards. Thus, poor households get caught in a dismal cycle of selling when prices are depressed and then re-entering the market to buy when demand drives the price much higher. Scarce money goes toward buying maize and not much else. Should the cash run out before the next harvest, then hunger is assured, starvation possible, good health rare and chronic malnutrition persists.
21. Dixon estimates that women make up on average 46% of the of agricultural labor force in Africa but only if subsistence production is included as economic activity, along with other factors. See Dixon, R. 1982. "Women in Agriculture: Counting the Labor Force in Developing Countries". *Population Development Review* 8, pp. 558-559.
22. The rationale given for this lack of attention to women's contribution is that male farmers are more productive than farms of female-headed households. The weakness of this line of reasoning lies in the very issue discussed here and that is ignoring gender obscures the constraints that hinder women's productive capabilities. For more

discussion see Quisumbing, Agnes R. 1996. "Male-female differences in agricultural productivity: methodological issues and empirical evidence." *Economic Development and Cultural Change* 24(10): 1579-96; Due, J., and C. Gladwin. 1991. "Impacts of Structural Adjustment Programs on African Women Farmers and Female-Headed Households". *American Journal of Agricultural Economics* 73:1431-1439.

23. Gladwin et al. 2001. "Addressing Food Security In Africa Via Multiple Livelihood Strategies Of Women Farmers" p.4.
24. UNIMA Center for Social Research and SARDC-WIDSAA, 1997. *Beyond Inequalities: Women in Malawi*, UNIMA/SARDC, Zomba and Harare.
25. ibid.
26. ibid.
27. ibid.
28. World Bank, 1995. *Malawi: Human Resources and Poverty: Profile and Priorities for Action*, Washington, D.C.; Government of Malawi and UNICEF, 1993. *Situation Analysis of Poverty in Malawi*, Government of Malawi\UNICEF, Lilongwe. pp. 22, 77.
29. UNIMA Center for Social Research and SARDC-WIDSAA, 1997. *Beyond Inequalities: Women in Malawi*, UNIMA/SARDC, Zomba and Harare.
30. Goheen 1991.
31. Gladwin, Christina, Ken L. Buhr, Abe Goldman, Clifton Hiebsch, Peter E. Hildebrand, Gerald Kidder, Max Langham, Donna Lee, Peter Nkedi-Kizza, and Deirdre Williams, 2001."Gender and Soil Fertility in Africa",p.3 – 4.
32. Gladwin et al. 2001.
33. Dixon, R. 1982. "Women in Agriculture: Counting the Labor Force in Developing Countries", *Population Development Review* 8:558-559; Gladwin, C.H., and D. McMillan. 1989. "Is A Turnaround In Africa Possible Without Helping African Women To Farm?", *Economic Development and Cultural Change* 37:279-316.
34. Benson, Todd. !997. The 1995/96 Fertilizer Verification Trial – Malawi: Economic Analysis of Results For Policy Discussion. Report by Action Group I, Maize Productivity Task Force. Ministry of Agriculture and Livestock Development, Government of Malawi, Lilongwe. p.1.
35. Benson, !997, p.7.
36. Admittedly, there has to be variations of gender relations in married households and I am not saying here that all married women have an equally subservient role to their husbands. For example, in some households, there may be much more consultation between husband and wife than in others. But how much occurs is very difficult to determine. All that we can safely say is that a woman in a FHH does make all the decisions and a man in a MHH has the final decision – we just do not have any idea how much of his wife's influence is incorporated in that decision.
37. Williams, Deirdre. 1996. "Gender and Soil Fertility Decisions: Initial Report, Maseno, Kenya". Paper submitted to the Institute of Food and Agricultural Sciences, University of Florida, Gainesville. p.2
38. Gladwin, Christina. 1989. *Ethnographic Decision Tree Modeling*. California, Sage Publications

39. ibid p.15.
40. ibid p.16.
41. According to well – documented research substantiated in field trials, pigeon pea grown as an intercrop with maize improves the soil by dropping leaves as it matures. Additionally, its deep roots draw up minerals that have leeched far beyond the reach of the roots of grain crops such as maize. Pigeon pea transports these minerals back to the surface, making them available for shallow rooted crops.
42. Legumes are nitrogen fixing but that does not mean the legume is distributing nitrogen (N) throughout the immediate soil vicinity. Sarrantino explains it quite clearly. "While it is tempting to think of legume nodules as little fertilizer factories pumping N into the surrounding soil, that isn't what happens. The fixed N is almost immediately shunted up into the stems and leaves of the growing legume to form proteins, chlorophyll and other N-containing compounds. The fixed nitrogen will not become available to the next crop until the legume decomposes. Consequently, if the aboveground part of the legume is removed for animal fodder, the majority of the fixed nitrogen also leaves the field. What about the legume roots? Under conditions favoring optimal N fixation, a good rule of thumb is to think of the nitrogen left in the plant roots (15 to 30 percent of plant N) as being roughly equivalent to the amount the legume removed directly from the soil, and the amount in the stems and leaves as being equivalent to what was fixed.
43. Annual legumes that are allowed to flower and mature will transport a large portion of their biomass nitrogen into the seeds or beans. Also, once the legume has stopped actively growing, it will shut down the N-fixing symbiosis. In annual legumes this occurs at the time of flowering; no additional N gain will occur after that point. Unless you want a legume to reseed itself, it's generally a good idea to kill a legume cover crop in the early- to mid-blossom stage. You'll have obtained maximum legume N and need not delay planting of the following cash crop any further, aside from any period you may want for residue decomposition as part of your seedbed preparation."
44. What legume is grown also matters. For instance, not one of the farmers in my survey who planted groundnuts returned the leaves to the field. The nuts were separated from the plant and the leaves were used as fodder, either for their goats or for their neighbors. Interestingly, the farmers in the surveyed said that they knew the leaves would benefit the soil. However, they chose not to return them to the field but use as fodder for goats. I offer this as an example of the disconnect between what the farmers believe and the actual practice they engage in. Even if turning the still green leaves into the soil after harvest only slightly benefits the soil, farmers in this survey were choosing not to do so, whether with groundnuts or pigeon pea.
45. See Sakala, W.D., G. Cadisch and K.E. Giller. 2000.
46. This was brought out even more so in another section of the questionnaire. Asking them about buying fertilizer on credit, 66% said they were afraid of credit so much they would rather not join a club – for many farmers the only way to get enough fertilizer was on credit. Male farmers were less fearful, with 50% saying so whereas 70% of MF and 76% of FHH feared credit. But when asked if they feared hunger more than credit if they did not obtain fertilizer, only one farmer – a married woman – said no.

47. The potential of even small quantities of fertilizer on yields was substantiated with the Starter Pack program begun in 1998. The package entailed giving 10 kgs of fertilizer along with hybrid seed – enough for 0.1 ha - and pulses to every household. The harvest was a near record and many attributed this to the program.
48. D'Arcy 1998.
49. Gladwin et al. 1997.
50. Uttaro 1998.
51. In July, 1998 the cost per kg for 23-21-0 + 4S in a 50 kg bag was MK15. Packaged in a 5 kg bag the price was MK 25 per kg or a 66% premium. The premium was justified due to packaging and the ever-offered transport costs although it is hard to see how. Two 25 kg bags take up as much room on a truck as one 50 kg bag. Other factors such as material and labor should result in only a slight increase.
52. I conducted a short duration experiment around Malosa in July, 1998 where I sold fertilizer by the kg in rural trading centers. I wanted to see if farmers would purchase fertilizer by what they could afford rather than at a set amount. The price per kg was 33% higher than the price per kg in a 50 kg bag in order to cover costs and provide a slight profit. The response was extraordinary and by the second week, people were waiting for the "mzungu" to arrive with fertilizer. What made it even more encouraging was that the experiment was taking place during the height of the dry season with at least 4 months before the beginning of the planting season. It also was extremely encouraging that many of the customers were women. The down side was that the experiment, as such, lasted only three weeks and farmers were begging us to keep coming particularly as the planting season approached.
53. Further evidence is provided by responses to the question "Does your soil need chemical fertilizer for good yields?". 94% of male farmers, 91% of Married women farmers and 100% of Female Headed Households replied in the affirmative.
54. The sale of the strategic grain reserve by the government of Malawi in 2001 was also injurious to small holder farmers in that it flooded the market with grain just as farmers were trying to sell their maize, further depressing producer prices. In 2002, facing starvation, millions of smallholders now have no cash to buy food.
55. See Arizo-Nino, E. 1991. *Women Farmers and Agricultural Policies in Malawi*. Report for USAID/PPC/WID.
56. Pauline Peters, conducting research in the Zomba area, found 47% of the sample growing hybrid to be the lowest percentage since 1990/91. The reasons given were high cost of seed and fertilizer. See "Maize, Food and Tobacco in Zomba: Situation Report, 1996" by Pauline Peters, Harvard Institute for International Development, August, 1996.
57. "Man-made Food Crisis Grips Southern Africa." Nicole Itano, *Christian Science Monitor*, May 15, 2002.

References

Adedeji, Adebayo, 1989. "Interaction Between Structuralism, Structural Adjustment and Food Security Policies in Development Policy Management", ECDPM Occasional Paper, Maastricht.

Alamgir, Mohiuddin and Arora, Poonam. 1991 *Providing Food Security For All* London: International Fund for Agricultural Development (IFAD)/Intermediate Technology Press.

Arizo-Nino, E. 1991. *Women Farmers and Agricultural Policies in Malawi*. Report for USAID/PPC/WID.

Benson, Todd. 1997. The 1995/96 Fertilizer Verification Trial – Malawi: Economic Analysis of Results For Policy Discussion. Report by Action Group I, Maize Productivity Task Force. Ministry of Agriculture and Livestock Development, Government of Malawi, Lilongwe.

Boserup, E. 1970. Woman's Role in Economic Development. St. Martin's Press, New York.

Brown, D., S. Reutlinger and A. Thompson. 1996. *Malawi: Food Security Within a Market Oriented Economy.* Agricultural Policy Analysis Project, Phase III. USAID. Washington, D.C.

Christian Science Monitor, May 15, 2002. "Man-Made Food Crisis Grips Southern Africa", Nicole Itano

D'Arcy, R. 1998. "Gender and Soil Fertility in the VEZA/HODESA Program of Malawi." Gainesville, FL: Report to the "Gender and Soil Fertility in Africa" Soils Management CRSP (Collaborative Research Support Program).

Dixon, R. 1982. "Women in Agriculture: Counting the Labor Force in Developing Countries". *Population Development Review* 8, pp. 558-559.

Due J. and C. Gladwin. 1991. "Impacts of Structural Adjustment Programs on African Women Farmers and Female-Headed Households". *African Journal of Agricultural Economics* 73:1431-1439.

Gladwin, Christina. 1989. *Ethnographic Decision Tree Modeling.* Newbury Park, CA: Sage Publications.

----------------------------and D. McMillan. 1989. Is a turnaround in Africa possible without helping African women to farm, Economic Development and Cultural Change 37: 279-316.

--------------------- 1992. "Gendered Impacts of Fertilizer Subsidy Removal Programs in Malawi and Cameroon". *Agricultural Economics* 7: pp. 141-153.

Gladwin, Christina, Anne M. Thomson, Jennifer S. Peterson, and Andrea S. Anderson. 2001. "Addressing Food Security In Africa Via Multiple Livelihood Strategies Of Women Farmers." Food Policy 26: 177-207.

Gladwin, Christina, Ken L. Buhr, Abe Goldman, Clifton Hiebsch, Peter E. Hildebrand, Gerald Kidder, Max Langham, Donna Lee, Peter Nkedi-Kizza, and Deirdre Williams, 2001. "Gender and Soil Fertility in Africa," in R. Buresh and P. Sanchez, eds. Replenishing Soil Fertility in Africa, SSSA Special Publication 51. Madison, WI: Soil Science Society of America (SSSA), 1997.

Goheen, M. 1991. "The Ideology and Political Economy of Gender: Women and Land in Nso, Cameroon," in: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers. Gainesville, FL: University of Florida Press, pp. 239- 256.

International Food Policy Research Institute. 1997. "Food Gap Widening in Developing Countries: One in Four Children Worldwide Will Be Malnourished in 2020".

Owens, Patricia. 1999. *When Maize and Tobacco Are Not Enough: A Church Study of Malawi's Agro-Econony.* 2nd edition, Peggy Owens, ed. CLAIM, Blantyre.

Quisumbing, Agnes R. 1996. "Male-female differences in agricultural productivity: methodological issues and empirical evidence." *Economic Development and Cultural Change* 24(10): 1579-96.

Reutlinger, S. 1985. "Food Security and Poverty in LDCs" Finance and Development, vol. 22, no. 4, pp 7 – 11.

SADC Food Security Quarterly Bulletin, October, 2001.

Sakala, W.D., G. Cadisch and K.E. Giller. 2000. Interactions between the residues of maize and pigeonpea and mineral N fertilizers during decomposition and N mineralization. Soil Biol. Biochem. 32:679-688.

Sarrantonio, M. 1998. Building Soil Fertility and Tilth with Cover Crops. pp. 16-24. In Managing Cover Crops Profitably, 2nd ed. USDA Sustainable Ag. Network, Beltsville, MD.

Shapouri, Shahla and Stacey Rosen. 1999. *Food Security Assessment: Why Countries Are At Risk* Market and Trade Economics Division. Agriculture Information Bulletin No. 754. USDA, Washington, D.C.

Staatz, J., 1990. "Food Security and Agricultural Policy" in T.R. Frankenberger et al., Proceedings of the Agricultural-Nutrition Linkage Workshop, Volume I, USAID, Arlington

Subcommittee on Nutrition of the United Nations/International Food Policy Research Institute, 1999. Fourth Report On the World Nutrition Situation. SCN?IFPRI, Washington.

UNICEF, Namibia, 1991. *A Situation Analysis of Children and Women in Namibia.* UNICEF, Namibia.

UNICEF, 1990. "Strategy for Improved Nutrition of Children and Women in Developing Countries", UNICEF Policy Review, New York.

UNIMA Center for Social Research and SARDC-WIDSAA, 1997. *Beyond Inequalities: Women in Malawi*, UNIMA/SARDC, Zomba and Harare.

United Nations, 1988. Towards Sustainable Food Security: Critical Issues, Report by the Secretariat, World Food Council, Fourteenth Ministerial Session, Nicosia, Cyprus, 23 – 26 May.

USAID/FEWS NET. Nov-Dec 2001 Monthly Report

Uttaro, R.P. 1998. "Diminishing Returns: Soil Fertility, Fertilizer, and the Strategies of Farmers in Zomba RDP in Southern Malawi." Gainesville, FL: Report to the "Gender and Soil Fertility in Africa" Soils Management CRSP (Collaborative Research Support Program).

Von Braun. 1991. "A Policy Agenda for Famine Prevention in Africa" Food Policy Report, International Food Policy Research Institute.

Williams, Deirdre. 1996. "Gender and Soil Fertility Decisions: Initial Report, Maseno, Kenya. Paper submitted to the Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL.

World Bank, 1986. *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*, World Bank Policy Study, Washington, D.C.

World Bank. 1990. *Symposium on Household Food Security and the Role of Women*. Harare, January 21-24, 1990.

World Food Programme and World Bank. 1991. *Food Aid in Africa: An Agenda for the 1990's* Rome, May.

Reference Style: The following is the suggested format for referencing this article: Uttaro, Robert. "Diminishing Choices: Gender, Small Bags of Fertilizer, and Household Food Security Decisions in Malawi." *African Studies Quarterly* 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v5/v6i1a4.htm

Gendered Scripts and Declining Soil Fertility in Southern Ethiopia

MICHAEL DOUGHERTY

Abstract: Enset (*Ensete ventricosum*) is a banana-like plant grown throughout the Southern Highlands of Ethiopia as the major staple food crop by many cultural groups. The issue of soil fertility among enset-growing farmers of Sidama, located in the Southern Region of Ethiopia, is embedded within the larger process of how a household makes a living. The traditional Sidama enset production and processing script presented in this paper describes how enset production and processing fit into the larger household livelihood process. Enset growing households of Southern Ethiopia have undergone a gradual process of impoverishment over the past three decades. This erosion of household assets has tested the ability of the enset script to continue to meet culturally established and emerging household consumption objectives. While socioeconomic production conditions and household objectives have dramatically changed, the traditional enset production and processing rules have not kept pace. The impact of insufficient enset script adaptation on female-headed households is examined. The argument is made that the enset production script must be modified through farmer planning to be able to meet existing (and anticipated future) household consumption objectives under new socioeconomic conditions. It is argued that new soil improvement technologies, which will be an important part of this new, modified enset script, must be evaluated in terms of how they fit into the larger household livelihood system. It is concluded that participatory farmer planning is necessary to help households adapt the existing enset script to address changes in socioeconomic conditions and to meet changing household objectives.

Introduction

The main purpose of this paper is to highlight the need for analyzing soil fertility management and the adoption of soil improvement technologies among small farmers as only one aspect in the larger process of how households make a living. To illustrate how soil fertility management practices and household livelihood strategies in Sidama are intertwined, the increasing inability of the traditional Sidama enset production and processing script to meet existing household objectives under changing socioeconomic conditions will be analyzed. Particular attention will be given to the impact on female-headed households (FHHs). Studies conducted throughout Africa and the rest of the world show that FHHs are typically poorer, have less adult labor, grow relatively more subsistence crops than cash crops and in general have less access to financial and physical capital.[1] The final section of the article will examine some of the lessons learned from the analysis of scripts and suggest how these lessons can help future soil fertility improvement programs better achieve their goals of increasing food security.

http://www.africa.ufl.edu/asq/v6/v6i1-2a5.pdf

ISSN: 2152-2448

To analyze how soil fertility management is embedded within the household livelihood system, this paper employs the sustainable livelihoods analysis framework in the description of Sidama enset production and processing and the impact on FHHs.[2] The sustainable livelihoods framework highlights the need to examine the complex ways that people make a living given their assets and cultural, political, economic, and environmental contexts when designing development policy. The sustainable livelihoods framework emphasizes examination in five categories of inquiry:

- contexts, conditions and trends
- livelihood resources
- institutional processes and organizational structures
- livelihood strategies
- sustainable livelihood outcomes.[3]

This paper will cover only four of these five categories. Category three, institutional processes & organizational structures, will not be discussed here. Contexts, conditions and trends and livelihood resources will be briefly discussed to familiarize the reader with the Sidama enset production system. Livelihood strategies will be discussed using the example of the Sidama enset production and processing script. Livelihood outcomes will be examined using a brief case study of a FHH in Sidama.

Sidama soil fertility management practices are embedded within a complex set of gendered cultural rules, guidelines, standard operating procedures, or what Schank and Ableson describe as scripts.[4] It is argued here that these scripts are detailed representations of specific household livelihood strategies. As will be seen below, scripts provide a representation of household livelihood strategies in vivid detail, yielding important descriptive cultural information about how activities are completed, who is involved, and highlight the complex contingencies contained in household livelihood strategies. As will be seen below, scripts can be nested hierarchically with embedded decision points. The gendered relationships of household livelihood strategies that scripts represent provide an important tool for examining adoption and adaptation of soil fertility improvement technologies.

METHODOLOGY

The data on scripts and the gender division of labor used in this study is drawn from primary data from case studies of ten Sidama households in two communities conducted by the author and Degife Shibru in 2001. Due to the detail of the production data required for this study a case study research design was used. A snowball sampling procedure was used to select five households within each of the two study communities. Due to this research design, the conclusions drawn in this paper are based on the processes observed working in ten households in two communities and may be suggestive of processes operating on a wider scale.

Determining the generalizability of this paper's conclusions is left to other studies with generalizability as their express concern.

Descriptive secondary data is drawn with permission from an unpublished region-wide food security survey of Sidama (n=270 households) conducted by Degife Shibru in 2000 for the Sidama Zone Bureau of Agriculture.[5] A stratified random sampling design was used to represent households within the three major agroecological zones (lowland, midland, highland) of the Sidama Zone.[6]

GENDER ISSUES WITHIN THIS FRAMEWORK

This paper will discuss men and women's production roles, the gender division of labor, the gender division of skills and cultural knowledge, and gendered access to capital within the enset system. Discussion of these issues is necessary to understand the relationship between the process of soil fertility decline and households' choice of livelihood strategy, specifically enset production and processing activities. Understanding the connection between the process of soil fertility decline and choice of livelihood strategy is necessary for the design of effective policy to address food security. As will be seen by the case study of a FHH, the food security of this household, through the livelihood strategies it chose, is integrated in a community-wide process of enset land soil fertility decline.

WHAT ARE SCRIPTS?

People need cognitive tools to assist them in figuring out how to make a living in their complex and uncertain worlds. To help in this process, people create scripts to simplify and codify complex cultural information. Schank and Abelson define a script as "a predetermined, stereotyped sequence of actions that defines a well-known situation . . . a structure that describes appropriate sequences of events in a particular context."[7] People are usually unaware that these scripts even exist. They simply use them to complete everyday tasks. Complex localized agricultural production knowledge gradually becomes transformed into scripts as particular combinations of techniques are proven to be successful over time. Chayanov points out that to make a living, households must decide how to apply available resources to existing activities to meet their objectives, however these objectives are defined.[8] Scripts represent the standard operating procedures that people use to guide how they will make these important livelihood decisions.

Script formation helps to simplify the complicated web of interrelated factors into an easy to follow sequence of actions. Scripts are the result of a gradual distillation of the process down to its essential steps by generations of users. The script user is freed from having to think about the myriad factor dependencies involved in getting a particular job done. One need only follow the steps in the script. A script is practical and results oriented, hiding most of the logic from the user. The script has proven successful to others in the past and therefore the user need not spend time contemplating the complex underlying procedural details. This freeing of cognitive resources is one of the primary functional purposes of scripts.

An important aspect of scripts is that they embody generations worth of successful indigenous knowledge. Scripts have been developed over time, being incrementally adapted and handed down through the generations as a proven set of successful standard operating procedures that have met the socioeconomic and environmental conditions experienced in the past. Scripts of important activities are diligently taught by parents and learned by children. These scripts are important pieces of technological and cultural information. However, individuals are not inextricably bound by culture to follow these scripts. Often, pioneering individuals deviate from these scripts for a broad range of reasons.[9]

The scripts that people use everyday are usually preconscious or preattentive and are typically not written down on paper (writing being done almost exclusively by researchers).[10] The term "script" as used in this paper refers both to the preconscious, preattentive set of instructions that people use to get a job done (emic) and to the written form usually created only by researchers to represent peoples' preconscious instruction set (etic). Because of the tremendous amount of cultural information contained in these preconscious scripts, the creation a written form of these scripts by researchers can be an important tool for documenting household livelihood strategies.

A TYPOLOGY OF LIVELIHOOD STRATEGIES

Livelihoods are constructed as a portfolio of activities.[11] Livelihood strategies represent a web of choices individuals and groups make about how to make a living and are based on people's perceptions of how a mix of available activities can best meet their objectives with existing assets, in a particular context.[12] Steven Devereux has proposed a series of categories that form a continuum of livelihood strategies.[13]

"Poor households everywhere survive by pursuing a mix of livelihood strategies that seek to increase their income flows and stocks of assets (accumulation strategies), to spread risk through livelihood adjustments or income diversification (adaptive strategies), to minimize the impacts of livelihood shocks (coping strategies) and, *in extremis*, to prevent destitution and death (survival strategies)."[14]

For the purpose of this paper, one useful way of viewing this series of categories is as a continuum of asset accumulation.[15] At the 'positive' end (in terms of livelihood sustainability) of the continuum accumulation strategies gain assets, adaptive strategies may gain or lose assets, while both coping and survival strategies lose assets. Devereux makes the observation that non-erosive dis-accumulation often takes place in the coping category while erosive disaccumulation takes place in the survival category.[16]

Hussein and Nelson organize livelihood strategies differently, creating three categories: intensification, diversification, and migration.[17] However, this author proposes that intensification, diversification, and migration should not be seen as categories of livelihood strategies but as dimensions of particular strategies. When making livelihood decisions, individuals and households face a choice about whether to intensify or dis-intensify (extensify in the case of using more land in agriculture) production of a particular activity, regardless of whether it is an accumulation strategy or a survival strategy. Likewise in the case of diversification, when individuals and households consider their portfolio of activities they are also faced with the decision to diversify or specialize (which is independent of the decision to intensify/dis-intensify a particular activity). Finally, individuals and households must make a choice about the location of each activity.[18]

Livelihood strategies can also be discussed in terms of the institutional scales of a particular strategy. Five scales are commonly identified: intra-household, inter-household, community, market, and state. Table 1 groups examples of Sidama coping and survival strategies to food shortage into these five scale levels. Each of the livelihood strategy examples categorized into each of the five scale levels can be classified as either accumulative, adaptive, coping, or a survival strategy depending on the particular context of the household. As will be explained further in the case study, processing enset for other households could at one time be considered an adaptive strategy while at another time be considered a coping or survival strategy.

Table 1. Institutional scales of livelihood strategies. (adapted from Degife, 2001, p. 93)

Intra-household	diversify crop and livestock activities reduce consumption go without food eat wild crops process immature enset for consumption use own financial resources migrate (temporarily or permanently)
Inter-household	seek support from relatives share food, land, labor, equipment, or animals process enset for others
Community	participate in mutual- assistance organizations (idir, ayde, seera)
Market	do petty trading produce and sell rural crafts purchase food in market sell animals sell fuel wood and livestock grass sell immature coffee on the tree borrow money
State	receive famine relief participate in rehabilitation and development projects

Many coping and survival strategies are forms of informal safety nets.[19] Coping and survival strategies often involve simply the intensification of existing activities rather than engagement in new activities.[20]The strategies chosen as stress increases follow a predictable sequence based on the cost and reversibility of the action.[21] Informal safety nets are often based on patron-client relationships. The redistribution of wealth that these relationships provide are important coping and survival strategies for vulnerable groups such as FHHs.

STUDY AREA

The households interviewed for this study are located in the west-central part of the Sidama Zone of the Southern Region of Ethiopia. Sidama is both the name of the administrative unit and the Sidama ethnic group. The Sidama Zone is 7,672 square kilometers and the population is approximately 2.8 million people of which 94% of *kebeles* (smallest Ethiopian administrative district) are classified as rural.[22] The study area is commonly divided into three agroecological zones.[23] The semiarid lowland (Amharic: *qola*) of the Rift Valley comprises 30% of Sidama (1200-1500 meters above sea level; 400-800 mm average annual rainfall; 20.0-24.9E C average annual temperature range). The moist mid-altitude (Amharic: *woinadega*) comprises 54% of Sidama (1500-2300 masl, 1200-1600 mm average annual rainfall, 15.0-19.9E C average annual temperature range). The cool moist highland (Amharic: *dega*) comprises 16% of Sidama (2300-3500 masl, 1600-2000 mm average annual rainfall, 15.0-19.5E C average annual temperature range). The study sites are located in the *woinadega* areas of Shebedino and Dale *Woredas* (roughly a county-sized administrative district), approximately 30 miles south of the capital city of the Southern Region, Awasa. Rainfall tends to be bimodal (main rains: June-September, short rains: mid February-March) with rainfall becoming more continuous as elevation increases. However, the short rains are highly variable and since they often fail, farmers claim they are relying on them for grain production less and less.

Figure 1. Map of Ethiopia.

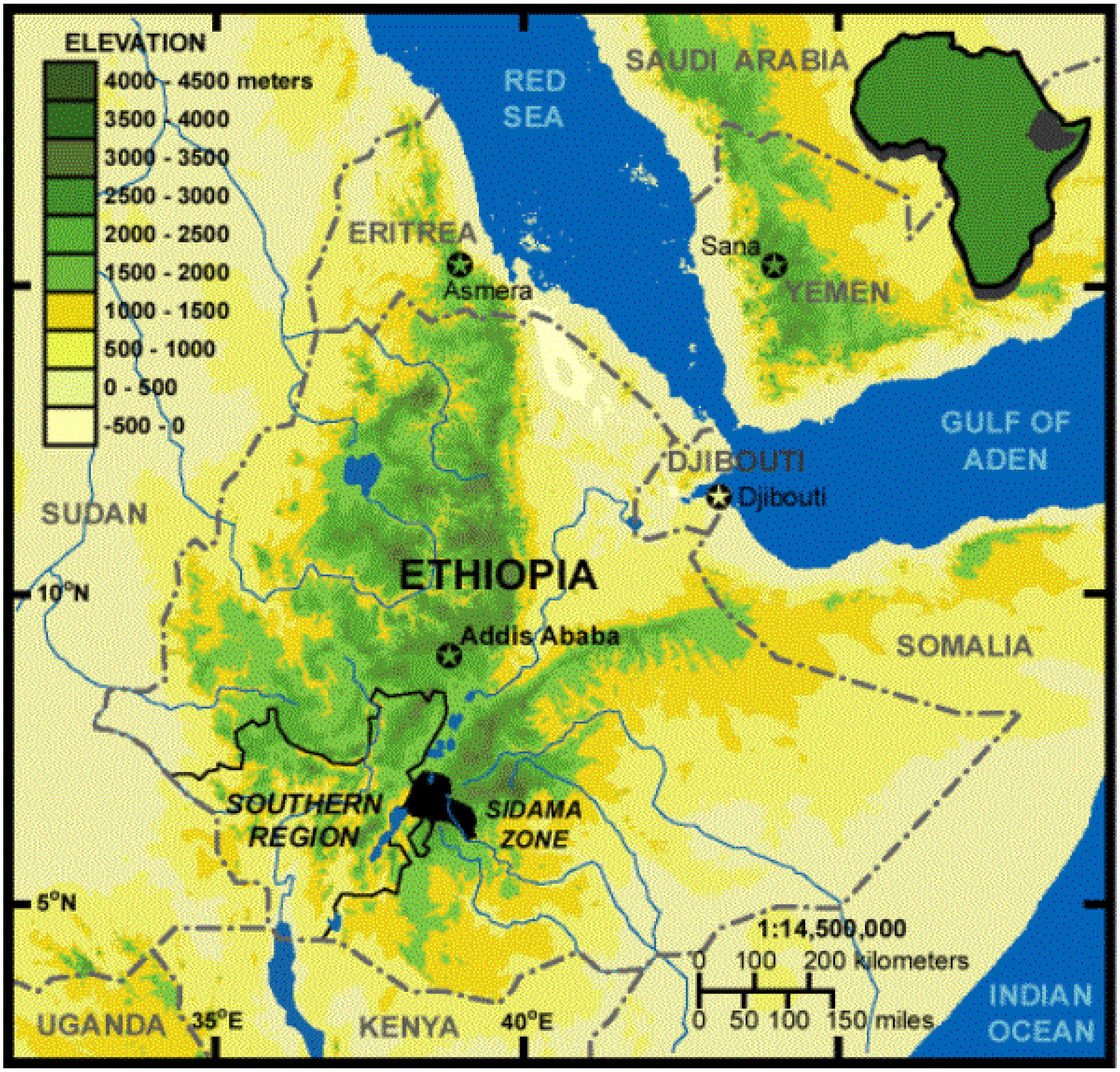
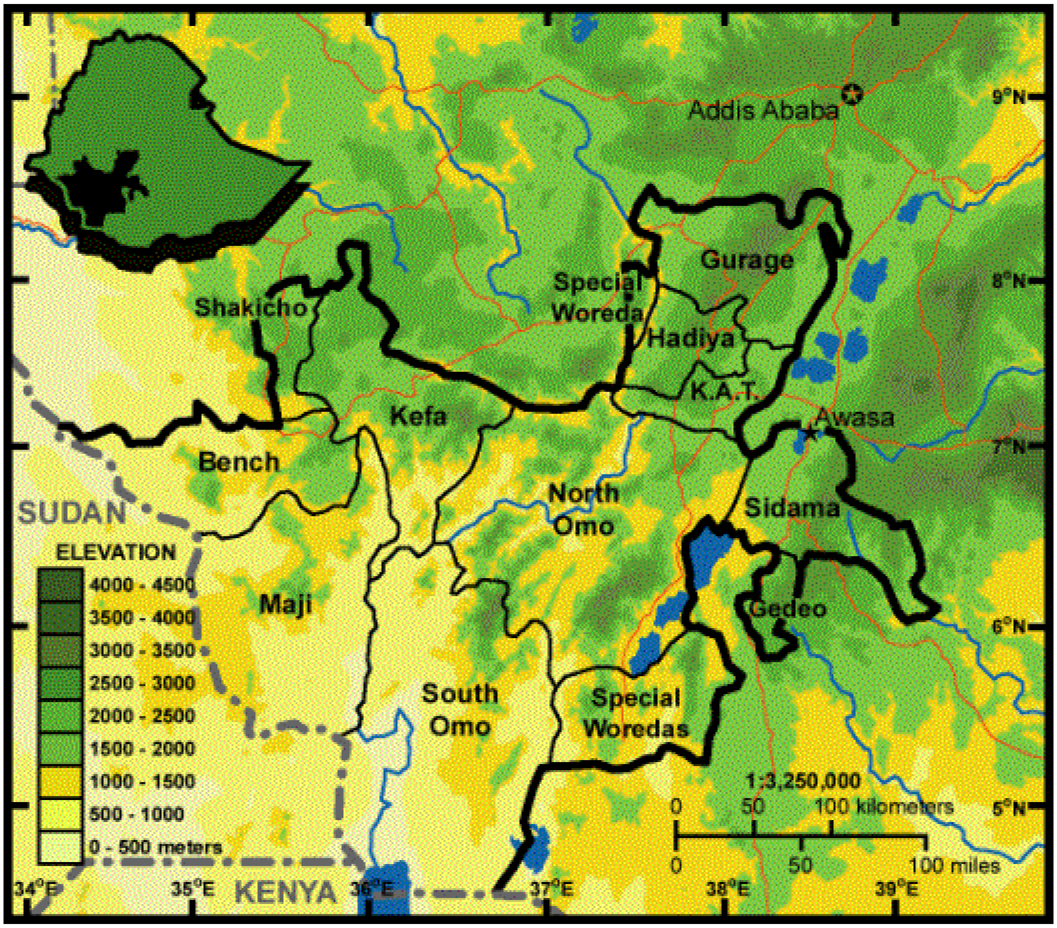


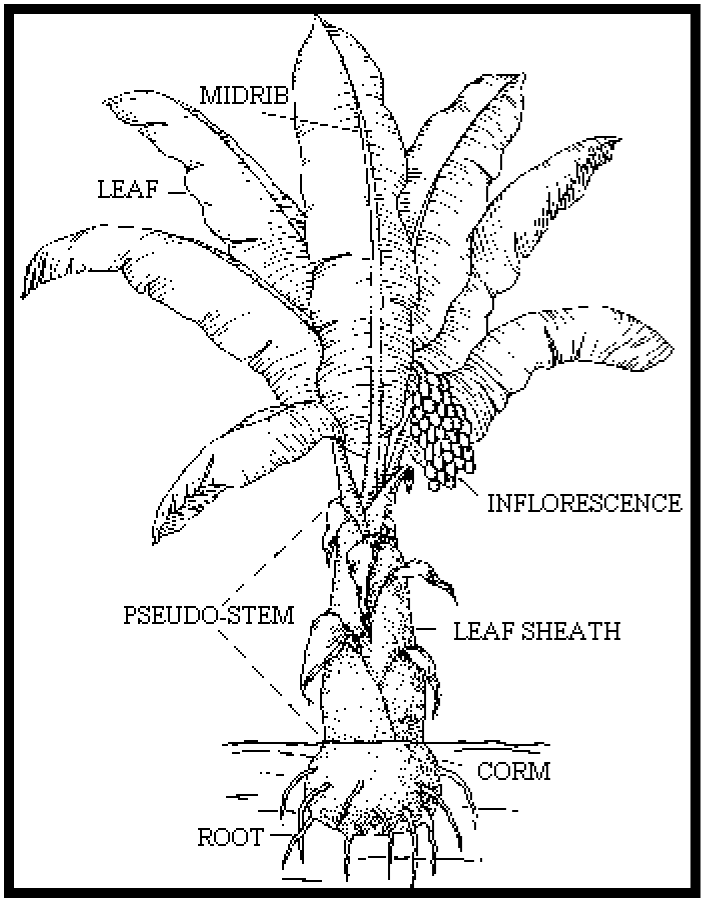
Figure 2. Map of Southern Region.



DESCRIPTION OF ENSET

Enset (*Ensete ventricosum*), is a long-lived, banana-like perennial plant used for food, fodder and fiber throughout the Southern Highlands of Ethiopia.[24] The part of the plant that is used for human consumption is not the fruit, but the enlarged pseudostem and underground corm that swell over time with carbohydrates. The leaves are mainly used for fodder and the fibrous pseudostem can be processed for fiber. Enset products are used for everything from food wrapping to medicine. What makes the enset system such an intriguing agricultural system is that enset plants are transplanted several times (2 to 4 times in highland Ethiopia depending on the cultural group) during their 3 to 12 year lifecycle.[25] In Sidama, enset plants are transplanted once and sometimes twice as will be explained in more detail below. Time to maturity varies widely depending on variety, management, and climate.[26] However, most of the variation is due to climatic factors that vary with elevation (time to maturity is positively correlated with elevation). Enset typically must be processed before it can be consumed as food by humans.2[7] An elaborate process is required to extract the starchy pulp from the pseudostem and corm of the plant. After extraction, an involved fermentation process is completed allowing the resulting food products to be stored for long periods of time, lasting months to as long as years.[28]

Figure 3. Diagram of the enset plant. [EnsetDiagram.gif]



From Brandt et al., 1997

STAGES OF ENSET GROWTH IN SIDAMA

The Sidama system of classifying stages of enset growth presented here is specific to Sidama (what Werner and Schoepfle call "native definitions").[29] Each enset-growing ethnic group has a unique system of enset production and classification.[30] Like the other enset-growing ethnic groups, the Sidama categorize enset into various stages of growth based on the age and size of each plant (Box 1). Moving from one stage to another occurs either due to transplanting or based on the size of a plant.[31] Enset plants in Sidama are transplanted only once, or if they are suppressed during the transplanted-sucker stage (awulo), they will be transplanted twice (dukalo). Individual enset plants are referred to by their stage name.[32]

Box 1. Stages of enset growth

Unsprouted-corm stage (sima) – The corm typically used for the propagation of enset suckers is ideally taken from a plant from the two-years-after-transplanting stage (simancho), however plants from other stages can be used producing suckers producing suckers with less vigor. The pseudostem of the enset plant is severed from the corm (see Figure 3), the apical meristem is removed, and the corm is buried with manure. “Sima” is the Sidamic term for the corm before the corm has sprouted new enset suckers. This un-sprouted corm stage (sima) lasts about 5 to 6 months.

Sprouted-corm stage (funta) – Once the un-sprouted corm (sima) has sprouted suckers, the suckers, still attached to the corm are referred to as in Sidamic as “funta”. No transplanting is done between the un-sprouted stage (sima) and the sprouted stage (funta). The sprouted enset plants (funta) grow, still attached to the corm (sima). The sprouted corm stage (funta) lasts about one year after sprouting. When the suckers (funta) are big enough to go to the next stage, the corm with the suckers (funta) still attached is uprooted and the suckers (funta) are divided from the corm.

Transplanted-sucker stage (awulo/kasho/kora) – Once the suckers (funta) are divided from the sprouted corm they are ready for transplanting. Suckers (funta) grown on the farm, purchased, or received from friends are transplanted to a new area and the plants are then referred to in Sidamic as “awulo,” “kasho”, or “kora”. During the transplanted sucker stage (awulo), the spacing of plants is regular. The transplanted sucker stage (awulo) lasts one year. The transplanted sucker stage (awulo) is usually weeded/manured 4 times.

One-year-after-transplanting stage (katalo) – The main purpose of the one-year-after-transplanting stage (katalo) is to thin out plants suppressed during the transplanted-sucker stage (awulo), allowing the vigorously growing plants to remain in place for further growth. After the thinning process is complete, the remaining plants are referred to in Sidamic as “katalo”. Plants will hereafter remain in their existing location until harvest; no further transplanting will take place. The spacing between plants will hereafter be irregular for the rest of each plant’s life. The one-year-after-transplanting stage (katalo) lasts one year.

Suppressed-enset-plant stage (dukalo) – Plants that are suppressed during the transplanted-sucker stage and are thinned-out at the beginning of the one-year-after-transplanting stage in Sidamic are called “dukalo.” Plants from the suppressed-enset-plant stage (dukalo) can either be used as livestock fodder and/or transplanted to a new area for further growth depending on the relative need for fodder and/or enset growing enset plants. The suppressed-enset-plant stage (dukalo) represents a branch in the primary progression of enset stages (sima, funta, awulo, katalo, simancho, malancho, etancho, bujancho, kalimo). If plants from this stage (dukalo) overcome their stunting, they will reenter the standard progression of enset stages (at the katalo stage) and become indistinguishable from those plants that traveled the through the primary progression of enset stages.

Two-years-after-transplanting stage (simancho) – From the two-years-after-transplanting stage (simancho) onward, the plants receive no further management until harvest. Typically this is the stage used for the propagation of enset suckers (funta). However, earlier stages are currently being used due to a shortage of two-years-after-transplanting stage (simancho). This stage lasts one year.

Three-years-after-transplanting stage (malancho) – Traditionally, harvest for human food begins at this stage. However, harvesting at stages as early as the one-year-after-transplanting stage (katalo) has become common due to the severe reduction in numbers of older plants in most households. This stage lasts one year.

Four-years-after-transplanting stage (etancho) – This stage lasts one year.

Five-years-after-transplanting stage (bujancho) – This stage lasts one year.

Mature-enset stage (kalimo) – This stage is when the enset plant reaches physiological maturity (flowering).

TYPES OF ENSET PROCESSING IN SIDAMA

There are several types of enset processing that are done in Sidama (hassa, shaqisha, howowicho, udee, ulaame). When a household determines that enset processing is necessary, harvesting of enset begins on an as-needed basis in one, linked harvesting/processing operation. Only two types of enset processing will be described here, primary harvest (hassa) and rainy season harvest (ulaame). For enset processing, several women from the community (since many of the operations require several people) are hired by a household and come together to process enset.

Box 2. Types of enset processing

Primary processing (hassa) - This is the main type of enset processing where the bulk of a household's enset products will be produced. Primary processing (hassa) takes place during the dry season (October-February). Enset plants from the three-years-after-transplanting stage (malancho) to the mature-enset stage (etancho, bujancho, kalimo) can be processed during primary processing (hassa). Primary processing (hassa) is conducted in three sizes of based on the number of enset plants to be processed. A large primary processing (big hassa), using 200 enset plants or more, is conducted by wealthy households with large enset plantations and provides even the largest households with sufficient food for more than one year. A medium primary processing (medium hassa), approximately 150 enset plants, and a small primary processing (small hassa), approximately 100 enset plants or less, are conducted by middle and low wealth households. Most households that conduct medium and small primary processings (hassa) typically do not have sufficient food to last until the following year. Farmers interviewed during case studies report that households engaging in large or even medium primary harvests (big and medium hassa) are rare or non-existent do to the low number of enset plants in most households' plantations. Most households engage in small primary processing (small hassa) using even fewer enset plants than have traditionally been used (indicated above).

Rainy season processing (ulaamme) - This is a secondary type of processing taking place during the early part of the rainy season (May-June) whose purpose is to bridge the food gap that exists for households with insufficient food to last the year (households conducting medium and small primary processings). Rainy season processing (ulaamme) is usually used to provide food before maize can be harvested (green or mature). Choice of rainy season harvest processing (ulaamme) is an important indication of food insecurity since it indicates that households are running out of processed enset products before the grain harvest (September-October) and forced to process enset again during the rainy season. Rainy season processing (ulaamme) is less favorable since it has lower labor productivity (1.5 person-days per quintal of processed enset compared to an average of 0.7 for big, medium, and hassa) and is lower yielding (2.1 plants per quintal of processed enset compared to an average of 1.6 for big, medium, and small hassa) than primary processing (hassa) during the dry season based on farmer estimates. Rainy season processing (ulaamme) is a particularly sensitive measure of food security. Since households with small enset plantations typically have no plants larger than the three-years-after-transplanting stage (malancho), they prefer not to conduct rainy season processing with plants from the three-years-after-transplanting stage (malancho) because of the resulting low quality products, but instead consume these plants without processing. Households conducting rainy season processing (ulaamme) can be classified as moderately at-risk, while households opting not to conduct rainy season processing but consume plants un-processed can be classified as severely at-risk.

STRENGTHS AND WEAKNESSES OF THE ENSET SYSTEM

The traditional enset system of the highland regions of Southern Ethiopia is an indigenous, famine-avoiding agricultural system unique to Ethiopia.[33] The primary strategic importance of enset in food security is that enset helps prevent famine by surviving during droughts when other food crops fail. Although enset is often said to be drought tolerant, it is not drought proof. Enset cannot be grown in semiarid areas. Enset must receive a minimum of about 1100 mm of well distributed rainfall annually for vigorous growth with less than 4-5 contiguous dry months since enset plants must rely on stored soil water to continue growing during dry seasons.[34] However, once enset plants are established in areas of sufficient rainfall they are able to tolerate occasional years of very low total rainfall or a short rainy season.[35]

Other strengths of enset-based livelihood systems include: storage longevity, multiple uses, and high energy productivity per unit area. The ability to store processed enset products for long periods of time with little storage loss provides households with a mechanism to smooth consumption during food shortage periods. Enset plants provide multiple products that serve many different purposes providing the opportunity to flexibly diversify production of different enset by-products (various fiber products, wrapping materials). Kefale and Sandford estimate that enset yields 1.3 to 3.5 times as much food energy per hectare per year as maize grown under similar management conditions.[36] For households facing a shortage of land, the higher energy productivity (based on area and time) of enset relative to cereals makes enset an important food security crop.[37]

However, enset-based livelihood systems do face some fundamental structural weaknesses including low protein content, bacterial wilt, continual harvesting, and the need for manure to maintain vigorous growth. The low protein content of enset products (12 g protein per kg of dry processed enset) compared to cereals (100g protein per kg of dry maize) leaves individuals vulnerable to protein deficiency as they come to rely more heavily on enset during crisis periods.[38] Whereas disease in annual crops threaten only the current year's harvest, diseases such as bacterial wilt (*Xanthomonas campestris*) in a perennial crop like enset threatens the harvest for several years into the future.[39] The enset system of production is capable of providing households with food security during periodic annual crop food production failures and other crises provided that these crises are separated by several non-crisis years when no enset harvesting takes place and the number of enset plants is allowed to increase. However, if crisis years are spaced too closely and reliance on enset during these crises requires harvesting large numbers of enset plants, the future capability of the enset plantation to provide food security is severely reduced.[40] Continual heavy harvesting of enset reduces the long term resilience of the enset system to provide food security. This reduction in enset system resilience is increased when the supply of livestock manure for enset fertilization is reduced due to the reduction of household landholdings and communal grazing areas and attendant reduction in livestock numbers that growing population causes.[42] Farmers interviewed for this study claim that without sufficient manure application, enset growth is not sufficiently vigorous to sustain the high harvesting rates caused by the continual state of crisis that many households now face.

Rapid population growth during the Twentieth Century has dramatically reduced the amount of land available for each household, reducing the number of livestock, and thus manure available for enset.4[2] In addition, the assets of many households have been eroded away as the result of a constant chain of low-level crises in the post-revolution period (1974 to present) due to a combination of factors such as erratic coffee prices, rainfall shortages, endless government restructuring, debilitating and inconsistent macro policy, periodic civil war, and official neglect.[43]

It is estimated that since prehistoric times the enset system has helped prevent famine in the region and 15 – 20 million people currently depend on enset either as a staple food crop or as a famine crop.[44] Historically, farmers throughout highland Ethiopia have incrementally intensified the enset system as they have been faced with gradually increasing population density. However, rapid contemporary population growth, and the social, political, cultural and economic changes it brings, now threatens further adaptation and the continued success of this once food secure agricultural system.[45] For many in high population density areas, continually shrinking household landholdings are pushing the limits of traditional strategies to provide households with a food secure livelihood. In the face of such rapid contemporary socioeconomic change, it is unclear how these households will be able to adapt their livelihoods to achieve food security.

SIDAMA LIVELIHOOD STRATEGIES

Sidama households have traditionally engaged in various combinations of livelihood activities including: cereals (maize, sorghum, barley, wheat, tef), legumes (beans, peas), root crops (enset, taro, potatoes, sweet potatoes), fruit trees (banana, avocado, citrus, mango), livestock (cows, oxen, sheep, goats, chickens, pack animals, bees), stimulants (coffee, chat), timber (eucalyptus), off-farm work (shopkeeping, civil service, trading, enset processing, laborer, priest) and trades (pottery, black smithing, weaving, basketry, building).[46] This is a list of the wide range of activities available in Sidama. However, no households would be engaged in all of these activities simultaneously. The combination of activities individuals and households choose depends on household resources, agroecological conditions, and the local and regional socioeconomic context. The overwhelming majority of rural Sidama are engaged in an integrated crop-livestock livelihood system.[47] One of the keys to success of traditional enset-based livelihood systems is maintaining the proper balance between livestock and access to manure as a source of soil fertility and the size and vitality of enset plantations.4[8] Enset is certainly not the only household livelihood activity, nor is it the most important. However enset has historically played a critical role in household food security. Off-farm work has increased in prominence with the increase in population and the resultant shrinking of household landholdings for crop and livestock activities. Households engaging in trades are more commonly found in urbanizing areas and are often stigmatized for working in trades.

While discussing these livelihood activities, people initially describe a rigid division of labor between men and women. Upon further discussion one discovers a great many exceptions to the general cultural rules governing men's and women's work and even more flexibility exists between adults' and children's work. Men are typically responsible for food crop planting and harvesting, cash crop land preparation and marketing, livestock production and marketing, off-farm work, and various trades. Women are typically responsible for child rearing, food preparation, housekeeping, food and cash crop weeding and processing, food crop marketing, and some trades. However these rough guidelines are obscured by a mass of conditionality. If children are not attending school, boys are expected to assist their father and girls their mother. If boys are in school, they may have no interest in farm work and do everything possible to escape it. Girls in school have little choice about their taste for work and tend to work almost as long as if they were not in school.

According to Degife, the mean household size in Sidama is 9.1 members.[49] Sidama contains a mix of multi-generational and nuclear households. Nuclear households formed by a son being given a portion of his father's land at marriage have been the ideal in Sidama (8 of 10 case studies conducted for this study). However, multi-generational households (2 of 10 case studies conducted for this study), with married children living with parents until their death, have become more common as household land holdings have decreased. Over 60% of sampled households have less than 1.0 hectare of land; the mean landholding is 0.84 ha. Approximately 98% of sampled households relied on the division of their parents' farm to obtain land. Degife reports that 6.7% of sampled households have insufficient land to divide a portion off for their children and still be left with a viable amount of land remaining. Fifty-two percent of sampled Sidama households report having 3 to 6 successors to the parents' land and 56.7% of households claim that the dividing of land for married children is the biggest constraint to agricultural production. These statistics suggest that land shortage pressure may be influencing some households to adopt a multi-generational structure to maintain farm-size viability.

Traditionally the Sidama were polygamous, however with the expansion of Protestantism (currently 78% of Sidama households) beginning in the 1930s polygamy has gradually shrunk.[50] Currently, 26% of households were polygamous, roughly proportional to the percentage of households belonging to religions condoning polygamy (Ethiopian Orthodox, Muslim, and Animist). Serial monogamy is another common practice (6 of 10 case studies conducted for this study). Although death of a spouse occurs (only 1 of 10 case studies conducted for this study), divorce is a more common cause of the serial monogamy phenomenon (5 of 10 case studies conducted for this study). Marital disputes often result in divorce and subsequent remarriage. Young wives often leave when their husband attempts to marry a second wife.

Due to the purposive sampling structure of Degife's Sidama regional food security survey, 10% are FHHs and 90% are male headed households (MHH).[51] Less than 1% of household heads are single and not widowed. The statistics for the number of FHHs and widowed household heads are identical (10%). This implies that almost all FHHs are widowed and that most divorced women get remarried relatively quickly. This interpretation of these figures is supported by the case studies conducted for this study. All of the case studies were male headed at one point, including both households that were female headed in 2000/2001 (both widowers). Most men reported preferring to marry young wives regardless of their own age and tended not to marry widowed women (0 of 8 MHHs married widowed women, 2 of 2 widowed FHHs remain unmarried at the time of the interviews and consider themselves very unlikely to remarry). Until the most recent regime, women had no legal property rights (officially there is no private land ownership, all land is owned by the state and long term leases are granted). Despite the recent national law that gave women the right to lease land, women in rural areas throughout most of Ethiopia are rarely able to gain access to land independent of a male relative.

However, FHHs tend not to remain female headed very long. After the death of a male household head, the search for a successor begins immediately. Sons that are interested in farming will become the new household head when they are old enough to marry, until that time the household remains female headed. In Sidama, FHHs are ideally only a temporary state. Why? Without a male household head, a female household head is particularly vulnerable to land claims that can potentially be made by her husband's male relatives.[52] Due to widespread land shortage, there is intense pressure for Sidama households to name a male successor. Therefore, FHHs, especially those with prime land, must often struggle with the delicate question of identifying a successor and must defend their children from rival male relatives.[53] Those FHHs that remain female headed for an extended amount of time are likely to be virtually landless (see case study below). Sidama property rights regimes and the cultural norms governing FHH formation and dissolution conditions FHHs choice of livelihood strategy as shown in the case study below.

THE SIDAMA ENSET PRODUCTION AND PROCESSING SCRIPTS

The enset production and processing script presented here developed over centuries and has remained relatively unchanged despite the dramatic socioeconomic changes experienced during the Twentieth Century. The Sidama today produce and process enset much the same as they have for centuries. The only notable exception is the option of using inorganic fertilizer that emerged with increasing coffee extension that occurred in the later decades of the Twentieth Century. However, inorganic fertilizer is a very recent occurrence and its routine use has not been widely integrated by most farmers into the enset production script (Box 3). Although the inorganic fertilizer decisions are included in this script, most farmers quickly rule out its use, primarily due to cost and other constraints discussed briefly below.

During the case study interviews, when people are asked about who does what in Sidama, everyone claims that men are responsible for enset production and women are responsible for processing. However, this does not mean that only men are involved in production and only women are involved on processing. Upon further observation and questioning it becomes clear that both men and women are both involved in a range of activities ideally deemed appropriate only for the other sex. This crossing of gender lines is especially marked in FHHs and in their case little of what follows in terms of division of labor applies. These gender dynamics make more sense when traditional Sidama men and women's production roles are further examined.

Sidama believe that men's role is to produce enset and that women's role is to process enset. Men and women ideally have separate production domains, where one may enter the other's domain, but strictly on the other's terms. For example, although men may participate in specific aspects of enset processing (digging pits, mixing, squeezing, transporting enset products around processing areas), women are clearly in charge of the whole procedure, doing the skilled operations, and making all decisions with men largely following orders (Boxes 4 and 6). The same is true of enset production, with women providing much of the manuring and weeding labor, with men in charge of the operation, making most of the critical decisions, and doing the skilled operations (Boxes 3 and 5). There are two possible exceptions to this concept of gender domains that seem to prove the rule, one for production and one for processing (these decisions will be marked with an asterisk in the scripts for distinction). First, although men are responsible for enset production, men and women (often heatedly) discuss what mix of enset varieties ("clones" since enset is vegetatively propagated) will be propagated or bought based on the different qualities valued by men and women.[54] The second exception is that men and women debate which clones and how many enset plants from each stage will be harvested for processing due to the different objectives of men and women. One explanation for these domain exceptions (women "meddling" in enset production and men "meddling" in enset processing) is that these are two decisions where men and women's domains overlap. The production decision about what clones to propagate and/or buy and plant can cause conflict between men and women because different enset clones have different uses.[55] Another traditional domain of Sidama women (as elsewhere) is providing food for the household, and another traditional domain of Sidama men is livestock production. Since enset can be used both for human food and animal fodder (as well as for other purposes, adding to its politicization), men and women often compete for enset products to meet the various needs within their domains. This competition for enset resources precipitates a complex process of negotiation between men and women within the household to fill their roles. As one might expect, this process plays out in a range of ways for different households and is beyond the scope of this paper.

Box 3. Enset production and processing script.
October-November, year 1 – Sub-script: Prepare land for propagation (sima).

Female labor: 1 hour/corm	Male labor (hired or household): 2 hour/corm

Four steps are required for bed preparation. First a small amount of land (about 4 sq. m per corm) is selected, usually near the house. Second, manure is applied prior to tilling. Transportation of manure from the house to the enset field has traditionally been the sole responsibility of women and girls. This is onerous work and everyone complains about it. One basket holding about 4 to 6 kg of manure (gimbola) is placed between the spots where the corms will be planted. The third step is done with a chest-height, double-poled hoe (wenencho) used to turn the grass under. The fourth step is done with a short handled hoe with a wide blade (jamba, safuya). The hoe is used to cut-up the turned clods of soil and mix the manure into the soil. Men typically do tilling.

November-December, year 1 – Sub-script: Propagate suckers (sima).

Female labor: none	Male labor: 1 hour/2 corms

There are three steps in propagation. First, typically corms from the two-years-after-transplanting stage (simancho) are used for propagation, however other stages can be used. The enset plant is prepared for propagation by removing the pseudostem of the plant just above the corm and the pseudostem is processed along with a sufficient quantity of other plants (for processing details, see Box 4). Second, the central shoot of the corm is cut out to induce the budding of sprouts from auxiliary buds. Third, holes are dug at 1.0 m spacing and the corm is buried.

February-March, year 2 – Sub-script: Weed unsprouted corm (sima).

Female labor: none	Male labor: 1 hour/2 corms

The unsprouted corm stage (sima) is weeded once approximately two months after planting at the end of the January-February rains (belg). No manuring is done at this weeding since manure was applied during land preparation. Men typically do weeding. There are two steps to this weeding. First, large weeds are pulled-up by hand, the dirt is knocked-off, and the weeds are left as mulch. Second, small weeds are simply hoed under using a short handled hoe with a single pointed head (helako or tike).

September-October, year 2 – Sub-script: Weed sprouted corm (funta).

Female labor: none	Male labor: 1 hour/2 corms

The sprouted corm (funta) is weeded once, typically after the June-September rains (meher). No manuring is typically done at this weeding since manure was applied during land preparation. The weeding process is exactly the same as the weeding of the unsprouted corm.

January-February, year 3 – Sub-script: Prepare land for sucker transplanting (awulo).

Female labor: 0.5 hours/2 sq. m plot	Male labor: 2 hours/2 sq. m plot

Four steps are required for bed preparation. First, a plot (about 2 sq. m) must be selected to plant the approximately 100 suckers produced from two average corms. Second, women prior to tilling apply manure. Typically, 1, 4 to 6 kg baskets of manure (gimbola) are applied to a 2 sq. m plot at this stage. The third step is done with a chest-height, double-poled hoe (wenencho) used to turn the grass under. The fourth step is done with a short handled hoe with a wide blade (jamba, safuya). The hoe is used to cut-up the turned clods of soil and mix the manure into the soil. Men typically do tilling.

March-April, year 3 – Sub-script: Transplant suckers (awulo).

Female labor: none	Male labor: 1 hour/2 sq. m plot

There are three steps to transplanting suckers. First, the sprouted corm is uprooted. Second, the suckers (funta) are divided from the corm. Third, suckers (funta) are transplanted at about 15-20 cm diagonal spacing (about 50 suckers/sq. m). Men plant suckers (funta) using a chest-height, single-poled hoe (wenencho). Once the suckers (funta) are planted thay are referred to in Sidamic as "awulo". Small, weak, or inferior suckers (funta) can be planted in groups of 2 or 3 plants in the same hole at the same spacing along with the vigorous suckers (funta). These stunted suckers planted in groups of 2 or 3 in the same hole once planted are referred to in Sidamic as "mugicho".

May-June, year 3 – Sub-script: Do first transplanted-sucker (awulo) weeding/manuring.

Female labor: 0.5 hour/2 sq. m plot	Male labor: 1 hour/2 sq. m plot

The first weeding (karkara) is typically done about two or three months after sucker (awulo) transplanting. There are three steps to this weeding. First, manure is placed between the plants by women. Approximately 20, 4 to 6 kg baskets of manure (gimbola) are typically applied to an area of 50 sq m. Second, manure is tilled-in by men using a short handled hoe with a single pointed head (helako or tike) during the weeding process. Large weeds are pulled-up by hand, the dirt is knocked-off, and the weeds are left as mulch. Small weeds are simply hoed under along with the manure. Third, for the plants that are growing vigorously, men turn down the leaves to prevent their suppression of the surrounding plants. Turning down the leaves at this time helps to equalize the growth across the cohort of plants. The turning down of leaves is done by grasping the leaf midrib near the base and rapidly snapping the midrib in a downward motion. The leaf is not necessarily totally removed. It can be left loosely attached to the plant, left as a mulch at the base of the plant, or fed to animals.

July-August, year 3 – Sub-script: Do second transplanted-sucker (awulo) weeding/manuring.

Female labor: 0.5 hour/2 sq. m plot	Male labor: 1 hour/2 sq. m plot

This weeding/manuring is done exactly the same as the first weeding/manuring operation except that the rate of manure applied is slightly reduced and leaves are managed slightly differently. Approximately 15, 4 to 6 kg baskets of manure (gimbola) are typically applied to 50 sq. m. During the second weeding, the leaves of all plants are turned down. Turning down the leaves at this time allows water to infiltrate better during the rainy season and helps to equalize the growth across the cohort of plants. Any plants that have died are removed and suppressed enset plants from the same cohort are transplanted into their place. The stunted suckers planted in groups of 2 or 3 (mugicho) are typically used to replace dead suckers.

September-October, year 3 – Sub-script: Do third transplanted-sucker (awulo) weeding/manuring.

Female labor: 0.5 hour/2 sq. m plot	Male labor: 1 hour/2 sq. m plot

Box 4. Sub-script: Do small primary processing (small hassa).

Starting October-February – Sub-script: Process pseudostem and corm.

Female labor (hired or household): 30 person days	Male labor (hired or household): 4 person days/

The purpose of this stage is to uproot the enset plants from the enset field and transport the plants to the processing areas and extract the pulp from the pseudostem and pulverize the corm. Women conduct the processing portion of this stage. Men assist women in the uprooting and transport of plants to the processing areas due to the large number of plants required for primary processing (hassa). The plants must be dug out of the ground and the leaves are removed using a knife (konchora). The following numbers of each stage are uprooted and transported to the processing areas. Ten, three-years-after-transplanting stage plants (malancho) are harvested per day for the first five days. Twenty-five, four-years-after-transplanting stage plants (etancho) and 25, five-years-after-transplanting stage plants (bujancho) if available. Enset plants are continually harvested and partially processed over approximately a 15 day period. Two women typically work together to process the enset plants. Each day as the plants are harvested and brought to the processing areas, the corms of the plants are processed in one area (corm processing area, CPA) and the pseudostems are processed in another area (pseudostem processing area, PSPA). In the PSPA, the starchy pulp (abicho) is extracted using a bamboo (sisicho) or metal scrapper to scrape the pseudostem while it lays on a slanting board (meeta) that is supported by a 'y' shaped vertical post (dawe). A pit is dug and lined with enset leaves under the slanting board (meeta) where the extracted pulp is placed. High quality fiber for making ropes, mats, etc. can be extracted from the inner portions of the pseudostem, while the tough outer portions of the pseudostem are saved and dried (shigido) for use as wrapping, tying, and for building material. At the CPA the outer soil-covered portion of the corm is pared-off and discarded. The corm is pulverized using a serrated tool made of cattle bone (keho). The pulverized corm (dassa) is placed into a two pit system lined with enset leaves that allows the liquid from pulp stored in an upper pit to drain into a lower pit when it is squeezed and mixed through treading with the feet. Each evening the pulp from the PSPA extracted that day (abicho) is brought to the CPA and mixed with the pulverized corm (dassa) in the higher pit. The combined mixture of processed pseudostem (abicho) and processed corm (dassa) pulp is then referred to as "abicho" (abicho + dassa = abicho). The starch-rich liquid that drains into the lower pit is allowed settle overnight, and in the morning the water is drawn off of the top and a fine, high quality starch is left behind (bulla). This routine continues until the appropriate number of enset plants have been harvested, requiring two women about 15 full days to complete.

5 days after pseudostem and corm processing started – Sub-script: Prepare fermentation starter (gamancho).

Female labor (hired or household): 0.5 person days	Male labor (hired or household): none

The purpose of this stage is to prepare a fermentation starter (gamancho) made from fermented sections of mature enset corms that will be used to help innoculate the processed pseudostem and corm to allow it to properly ferment to maturity. Women solely conduct this stage of processing. This stage runs concurrently with pseudostem and corm processing and is started about 20 days after harvesting and processing has begun. This stage takes about 8 to 10 days to complete and is therefore started about 10 days before the beginning of the next step must begin. Only corms from four-years-after-transplanting stage plants (etancho) and five-years-after-transplanting stage plants (bujancho) work properly for making the fermentation starter (gamancho). A section of the corm is cut off, rubbed with a piece of dried enset pseudostem (shigido) or other local plant (hecho, maraca, etc.). The corm is then tightly wrapped with pieces of dried enset pseudostem (shigido) to make an airtight wrapping (first sala) and left for 5 days. On the fifth day the wrapping is removed in the morning and allowed to air until evening. At this stage the corm is checked for proper ripening. The corm is fed to animals if not ripening properly and is not used for enset processing. On the evening of the fifth day the ripening corm is re-wrapped (second sala) and allowed to continue ripening for another 3 to 5 days.

After pseudostem and corm processing completed – Sub-script: Add fermentation starter (gamancho) to processed pseudostem and corm (abicho).

Female labor (hired or household): 1 person day	Male labor (hired or household): 1 person day

The purpose of this stage is to thoroughly and systematically mix the fermentation starter (gamancho) with the processed pseudostem and corm to start the fermentation process. The mixing can be completed in one day if five people are working and then requires about 5 days of maturation time before the next stage. The maturation of the fermentation starter (gamancho) is timed to coincide with the end of pseudostem and corm processing. Both men and women from the household or the community can participate in this stage of processing. To begin the mixing of the pseudostem and corm pulp (*abicho*), the pulp is transferred from the CPA to the PSPA. There the fermented corm (gamancho) is unwrapped, pulverized, and systematically mixed with the pseudostem and corm pulp (abicho) by treading with the feet. After the mixing of pseudostem and corm pulp (abicho) with the fermented corm (gamancho) is complete, the pulp is then moved from the PSPA back to the relined CPA pit for 5 days of maturation. The pulp is now referred to in Sidamic as "wassa".

5 days after adding fermentation starter – Sub-script: Do first mixing.

Female labor (hired or household): 1 person day	Male labor (hired or household): 1 person day

The purpose of the first mixing is to thoroughly mix the processed enset pulp (wassa) and test the adequacy of the fermentation starter (gamancho). Both men and women from the household or the community can participate in this stage of processing. The mixing can be completed in one day if five people are working and then requires about 5 days of maturation time before the next stage. The mixing is done at the PSPA and is done by treading with the feet. The liquid from the pulp is retained during this mixing to assist in getting the fermentation process started.

5 days after first mixing – Sub-script: Do second mixing.

Female labor (hired or household): 1 person day	Male labor (hired or household): 1 person day

The purpose of this mixing is to thoroughly mix the processed enset pulp (wassa). Both men and women from the household or the community can participate in this stage of processing. The mixing can be completed in one day if five people are working and then requires about 5 days of maturation time before the next stage. The mixing is done at the PSPA and is done by treading with the feet. The liquid from the pulp is retained during this mixing to assist in getting the fermentation process started.

5 days after second mixing – Sub-script: Do third mixing.

Female labor (hired or household): 1 person day	Male labor (hired or household): 1 person day

The purpose of this mixing is to thoroughly mix the processed enset pulp (wassa) and to remove the liquid from the processed enset pulp. Both men and women from the household or the community can participate in this stage of processing. The mixing can be completed in one day if three people are working and then requires about 5 days of maturation time before the next stage. The processed enset pulp is transported from the PSPA to the CPA and the liquid is squeezed out of the pulp through treading with the feet using the two-pit system. The liquid is retained for use as a fermentation starter in an auxiliary type of processing (shaqisha).5[6]

5 days after third mixing – Sub-script: Do fourth mixing.

Female labor (hired or household): 2 person day	Male labor (hired or household): 1 person day

The purpose of this mixing is to thoroughly mix the processed enset pulp (wassa) and to remove the last of the liquid from the processed enset pulp. Proceeds exactly the same as the third mixing except that there is no need to transport the processed enset pulp (wassa) to the CPA.

5 days after fourth mixing – Sub-script: Place in final pit.

Female labor (hired or household): 1 person day	Male labor (hired or household): 1 person day

The purpose of this final mixing is to squeeze the last of the liquid from the processed enset pulp (wassa) and place it into the final pit for long-term storage. Both men and women from the household or the community can participate in this stage of processing. The final squeezing and transfer can be completed in one day if five people are working. The squeezing is done by hand at the CPA. A pit, usually dug inside the house for theft prevention, is lined with enset leaves and the squeezed pulp is compacted in the pit by treading with the feet. An airtight seal is created over the pit using enset leaves and dried pseudostems (shigido) and the pit is covered with soil.

HOW THE SCRIPT WORKS

Scripts guide the user through the steps necessary to complete a job. Scripts are followed step by step, from top to bottom. The user moves (usually preconsciously) down through the script following the script's directions. Scripts can be represented hierarchically to hide more detailed information in sub-scripts. These scripts can be written to include as little or as much detail as necessary, depending on their intended purpose.

Most people use the same basic script. However, experts' scripts will contain more decisions, more complex decisions, and more operational details than inexpert people's scripts. Experts' sub-scripts are likely to be more precise, containing more exact timing of events and more explicit instructions regarding the execution of each operation. Sub-scripts of less expert enset farmers will likely be less precise. Since scripts are taught and learned, some people will naturally become more expert than others reflecting both their teachers' (typically parents) knowledge and their own intellectual ability and interest. The script presented here is a basic script that most, Sidama enset farmers would agree represents the essential information necessary to grow and process enset. Experts will think it lacks sufficient detail, while individuals with less than average enset growing and processing expertise will notice detail that they do not use. Since men are traditionally responsible for enset production, they tend to have more detailed knowledge of the production script than women and since women are traditionally responsible for processing enset, they tend to have more detailed knowledge of the processing script than men. However, since gender roles are not rigid, there are some experts, both male and female, that have extremely detailed knowledge of sections of the script they are not normally expected to know. FHHs provide an example of women forced by necessity to obtain more detailed production script knowledge, an area they are not normally expected to have expertise.[57]

Schank and Abelson point out that scripts are not able to handle novel situations, and in such novel cases planning is necessary.[58] As plans become routinized over time they are eventually transformed into new scripts. Enset farming experts often discover better ways of doing things by generating plans and through the routinization of these plans they modify the scripts they use to incorporate these innovations. For these experts, scripts are not preconscious as they likely are for most. Experts' intense interest and planning make them aware of the various steps and embedded decisions. Expert planning and script modification exists along a continuum from incremental refinement of the existing script (adding inorganic fertilizer with manure, processing tools creating less waste) to fundamental reorganization of the script (adoption of more intensive fodder production techniques).

Although most people use the same script, most people don't reach the same outcome. All enset farmers using the same script do not reach the same outcome because they do not follow the same path through the one script. For example a poor FHH with not enough land for enset may choose not to follow the production section of the script.[59] She would choose not to produce enset (Box 3) and would therefore skip the steps in the production section of the script. However, just because a household produces no enset does not mean that they exit the script entirely. FHHs often choose to process enset for other wealthier households. A wealthier MHH may choose to produce enset in such large quantities that the female labor within the household is insufficient to process all of the enset produced. Therefore, this MHH would choose to process some or all of its enset using outside labor (Box 4). The wealthier household chooses to process enset using hired labor and the FHH would continue following the processing steps (Box 4).

GENDER DIVISION OF ENSET LABOR

The labor time estimates in Boxes 3 and 4 are based on the total amount of labor necessary to produce and process 100 enset plants from propagation through processing.[60] The script format allows a cohort of plants to be followed from the beginning of the process until the end, documenting the male and female labor required along the way. These gender disaggregated labor estimates are summarized in Tables 2-4. One of the most striking set of numbers from this table is the remarkably low amount of time required for production and the large amount of time required for processing. Throughout the life of each plant, only about 11 minutes of labor is required on average for production (18 production hours x 60 minutes)/100 plants). In contrast, each plant requires on average over 3.6 hours of processing labor (364 processing hours/100 plants). Since women are largely responsible for processing enset (women provide 82.4% of processing labor), women provide about 80% of the total labor required for enset production and processing, whereas men provide only about 20% of the total labor requirement (Table 4).

Table 2. Gender division of enset production labor.

Operation	Women		Men		Total	
	hrs	%	hrs	%	Hrs	%
Prepare land for propagation	1.0	5.6	2.0	11.1	3.0	16.6
Propagate suckers	–		1.0	5.6	1.0	5.6
Weed unsprouted corm	–		1.0	5.6	1.0	5.6
Weed sprouted corm	–		1.0	5.6	1.0	5.6
Prepare land for sucker transplanting	0.5	2.8	2.0	11.1	2.5	13.9
Transplant suckers	–		1.0	5.6	1.0	5.6
Do first transplanted-sucker weeding/manuring	0.5	2.8	1.0	5.6	1.5	8.3

Do second transplanted-sucker weeding/manuring	0.5	2.8	1.0	5.6	1.5	8.3
Do third transplanted-sucker weeding/manuring	0.5	2.8	1.0	5.6	1.5	8.3
Do fourth transplanted-sucker weeding/manuring	0.5	2.8	1.0	5.6	1.5	8.3
Do thinning/transplanting	–		1.0	5.6	1.0	5.6
Do after-thinning weeding/manuring	0.5	2.8	1.0	5.6	1.5	8.3
Total	4.0	22.2	14.0	77.8	18.0	100.0

Table 3. Gender division of enset processing labor

Operation	Women		Men		Total	
	hrs	%	hrs	%	Hrs	%
Process pseudostem and corm	240	65.9	32	8.8	272	74.7
Prepare fermentation starter	4	1.1	–		4	1.1
Add fermentation starter to processed pseudostem and corm	8	2.2	8	2.2	16	4.4
Do first mixing	8	2.2	8	2.2	16	4.4
Do second mixing	8	2.2	8	2.2	16	4.4
Do third mixing	8	2.2	–		8	2.2
Do fourth mixing	16	4.4	–		16	4.4
Place in final pit	8	2.2	8	2.2	16	4.4
Total	300	82.4	64	17.6	364	100.0

Table 4. Gender division of enset production and processing labor

Operation	Women		Men		Total	
	hrs	%	hrs	%	Hrs	%

Enset production	4	1.1	14	3.7	18	4.7
Enset processing	300	78.5	64	16.7	364	95.3
Total	304	79.6	78	20.4	382	100.0

THE ENSET SCRIPT'S FOOD SECURITY PERFORMANCE

At the national level, Ethiopia has undergone a tremendous transformation during the post-revolution (1974) period. The following statistics from the Ethiopian Economic Association tell part of the story. Although Ethiopia is already ranked as one of the poorest countries in the world by almost any measure, many of the critical human development indicators appear to be getting worse, not better between the time of the first census in 1984 and the second census in 1994.[61] The population growth rate for Ethiopia in 2000 is estimated to be between 2.45 to 3.39% per annum.[62] Ethiopia already has the third largest population in Africa (currently approximately 60 million) and with 50% of the current population under the age of 17, these high rates of population growth can be expected to continue well into the future. National per capita food production has fallen consistently from 240.2 kg in 1960 to 141.7 kg in 1990.[63] Although the national total fertility rate (TFR) has decreased from 7.52 births per woman in 1984, to 6.74 in 1994, life expectancy (LE) appears to have dropped from 52.0 years in 1984 to 50.7 years in 1994. The national infant mortality rate (IMR) increased from 110 per 1000 live births in 1984 to 116 in 1994. The national under-5-mortality-rate (U5MR) increased from 166 deaths per 1000 to 171 in 1994. The statistics for the Southern Region (when available) are all worse than the national averages (TFR 7.16, LE 48.6, IMR 128).[64]

At the regional and household level, evidence can be found from Degife's Sidama food security study that helps to explain elements of this erosive process seen from the national level.[65] Mean household landholding size in Sidama is 0.84 hectares. With a mean household size of 9.1 persons, the ratio of cultivated land per person is very low (~0.09 ha/person). Consequently, 81.0% of sampled households report that their household's farmland is not sufficient for their household, while only 19.0% of households report having enough land. Eighty-seven percent of sampled households report that it is not possible to get more farmland, while only 12.9% of households report the possibility for getting more land.

The impact of this land shortage on food security is clear. Seventy-four percent of households report that their farm is not sufficient for food production, while only 25.1% report that their land is sufficient. Seventy-four percent of households report having insufficient food until the next harvest, while only 24.7% report having enough. Eighty-three percent of households reporting having enough cultivated area for food production also report having sufficient food until the next harvest, while 91.2% of households reporting not enough cultivated land for food production also report having insufficient food until the next harvest (Pearson chi-square 150.29, p value < 0.0005). This strong correlation implies that household food security is largely dependent on a household's land assets and consequently its ability to produce its own food. This finding is not surprising given the agrarian structure of the region.

Seventy-two percent of sampled households report that the grazing areas on their farm is decreasing, or not changing (17.0%), while none reported grazing land to be increasing. What is causing this reduction of on-farm grazing land? When respondents were asked to explain the reason for this decline in on-farm grazing land, 52.8% reported that the grazing land was needed for increased crop production, 44.0% reported a combination of expanding crop production and tree planting, and 2.9% needed more land for their house. To address the food insufficiency that many households are currently facing, it appears that many households are increasing the proportion of cultivated land planted with food crops at the expense of on-farm grazing land. Given farmers' reports of the decrease in the size of communal grazing areas and of an increase in stocking rates over time, this decline in on-farm grazing land has very detrimental effects on households' ability to maintain livestock.

As a result of the reduction of grazing resources, 54.9% of households report that fodder shortage is currently the biggest obstacle to keeping livestock. Seventy-nine percent of households report that the most severe fodder shortage occurs in the dry season, yet 88.4% of households report having no dry season fodder storage facilities. Although farmers are facing severe fodder shortages during the dry season, few farmers report adoption of more intensive methods of fodder production or storage.

Several important points can be made about the coping measures adopted by food insecure households. The first point to notice is that the most common response to food shortage is the selling of livestock (28% of households). Respondents interviewed for the case studies report that farmers have been surviving numerous crises partly through the sale of livestock and that livestock numbers have now reached a critical level. Table 6 provides survey data showing that for all livestock types the majority of households surveyed report decreasing livestock numbers over the past five years. Since 75.0% of households consider livestock production to be an important priority for future food security, repeated destocking episodes, although an effective short-term survival and coping strategies, cannot be considered a viable long-term strategy because it never allows livestock numbers to recover.

Table 5. Food insecurity coping and survival strategies

If the household does not have enough food until the next harvest, then how does the household manage to feed itself?	% of households
Sell livestock	28.5
Reduce the quantity and quality of food	19.0
Sell labor	15.9
Process immature enset	14.3
Petty trade	7.5
Sell immature coffee on the tree	1.9

Table 6. Changes in livestock over the past 5 years

Livestock type	% of households having each livestock type	% of households with increasing livestock during the last 5 years	% of households with decreasing livestock during the last 5 years	% of households with unchanged livestock during the last 5 years
Cows	93.3	27.0	63.8	4.4
Oxen	37.0	8.0	68.2	4.8
Sheep	29.5	21.5	57.0	21.5
Goats	31.9	17.4	64.0	18.6
Pack animals	33.3	10.0	48.9	41.1
Chickens	49.3	34.6	56.4	9.0
Behives	24.0	21.5	48.2	29.3

During the interviews for the case studies, farmers emphasized that the selling of assets such as livestock have limited the amount of manure that farmers can apply to enset fields to maintain soil fertility. The above script has no built-in contingencies for dealing with a lack of manure. Notice that the enset production script (Box 3) only provides specifics for the application of manure and nowhere even mentions how one should apply inorganic fertilizers. The enset production script contains no alternative soil fertility amendment options. The enset production script was constructed under the assumption that sufficient manure would be available to ensure vigorous growth. Most farmers tend to follow the script without modification. If they have less manure than the amount the script calls for, then they simply apply what they have. The amount of manure that the enset script specifies should be applied to enset is a function of the amount of manure necessary to obtain vigorous enset growth, not a function of manure supply. Farmers report that they are now forced to apply well below the amounts of manure necessary for vigorous enset growth due to the decline of livestock holdings. The application of inorganic fertilizers as an alternative to manure is only being tentatively tested by a few farmers as a soil fertility amendment replacement for farmers with declining access to manure. Farmers say that inorganic fertilizer can be used for enset, but that it is not as preferred as manure. They report that the land becomes "addicted" to fertilizer. They point out that once you start applying chemical fertilizer, you must continue or yields will drop quickly after stopping. The commonality of the 'addicted to fertilizer' response throughout Ethiopia is likely due to the biophysical process of declining soil organic matter resulting from the use of inorganic fertilizer versus manure rather than this information being culturally encoded and passed along via a script. Farmers claim that manure is preferred because it requires no cash outlay and the soil fertility is much longer-lived than with the application of inorganic fertilizer. However, farmers say that inorganic fertilizer is easy to apply and that they are familiar with its use because of experience gained applying it to coffee. However, farmers complain about the high cost of inorganic fertilizer. They point out that unless their coffee yields well and prices for coffee are good, they have no extra income to purchase fertilizer.

Farmers emphasize that the inorganic fertilizer price has only continued to rise and with recent devaluations that it is now almost totally out of reach even for wealthy households.

In the past livestock were abundant and enset groves received the bulk of the manure that supported the vigorous growth necessary to maintain the resilience of the groves to handle periodic heavy harvesting during grain crop failures. Now farmers are forced to plant enset without the addition of sufficient manure or none at all, resulting in stunted growth and lower yields (plants continue to age, but gain little weight). This author is unaware of any region-wide soil fertility studies that exist to empirically quantify the change in soil fertility status of enset fields. The only data that is available on soil fertility status is farmer testimony that enset yields are declining due to the lack of manure and the inferences that can be drawn from nutrient cycling studies with the knowledge that manure additions have declined.

In the past, the enset script was built around reliable cash income from coffee allowing many older farmers to hire labor for land preparation and weeding that would otherwise be difficult to complete. Increasingly erratic and declining coffee income means these older farmers often are unable to complete critical enset production activities, lowering yields and leaving dangerous gaps in the age structure of enset groves. Due to the low numbers of enset plants of harvestable age, most farmers in Sidama harvest only small primary processing (small hassa) to last the entire year, as mentioned above. The logic of the enset system, represented by the above scripts, never 'intended' for an entire household to survive for a whole year solely on one small primary processing (small hassa). Farmers emphasize that small primary processing (small hassa) were intended to augment other types of processing. Box 2 explains the interrelationship between the two types of processing types described in this paper. Medium and small primary processings (medium and small hassa) require a rainy season processing (ulaamme) to help bridge the food gap between when food runs out from the medium and small primary processings. However, farmers interviewed for this study report that many households have too few enset plants to conduct this second rainy season processing. These along with other examples provide some evidence that the traditional enset production and processing script is not operating according to its historic logic.

During the case study interviews, farmers claim that this series of crises have forced many Sidama enset-growing households to repeatedly harvest large amounts of enset to survive these crises. Degife's regional survey data shows that 57.8% of households report relying on enset to feed their animals during the dry season and 25.2% rely on a combination of enset and crop residues.[66] Fourteen percent of households report processing immature enset if the household does not have enough food until the next harvest (Table 2). Although these are important food security enhancing survival and coping strategies of enset agriculture, when used repeatedly they tax the resilience of the enset system. Coupled with declining soil fertility due to shrinking land size and the loss of livestock and access to manure causing enset plants grow less vigorously, farmers report that groves are now at critical levels. These periodic shocks have destroyed the ideal pyramidal age structure of enset plantations (many small young plants, a medium number of medium sized-medium aged plants, and few large old plants) through the continued harvesting of most large and medium sized plants.[67] Removal of the upper and medium layer of the pyramid has eliminated the resilience of the groves for protecting households against food security shocks in the short (1-4 years) and medium term (5-10 years).

Sidama households have been living off of the food security of the future to survive the crises of the past. Many household enset groves are at dangerously low levels. Their enset groves will now provide them with no cushion for future shocks. The groves need time to recover, allowing the young plants time to mature, while continuing to propagate a steady stream of young plants for the future. Finding new methods of soil fertility improvement that farmers can afford are a critical aspect in this recovery process.

Based on discussions with farmers, the script presented here is no longer providing households with food security as it once did. It is proposed that the failure of the enset script to provide households with food security today is because it is being applied outside its historical parameters. The script that once provided food security can no longer do so in its current form. The production rules of this script are valid for a former set of socioeconomic conditions. The socioeconomic conditions have changed, but the production rules (script) have not kept pace. If the food security capability of the enset system is to be restored, adaptation of the script is necessary to address the decline in soil fertility caused by the gradual loss of livestock from the system.

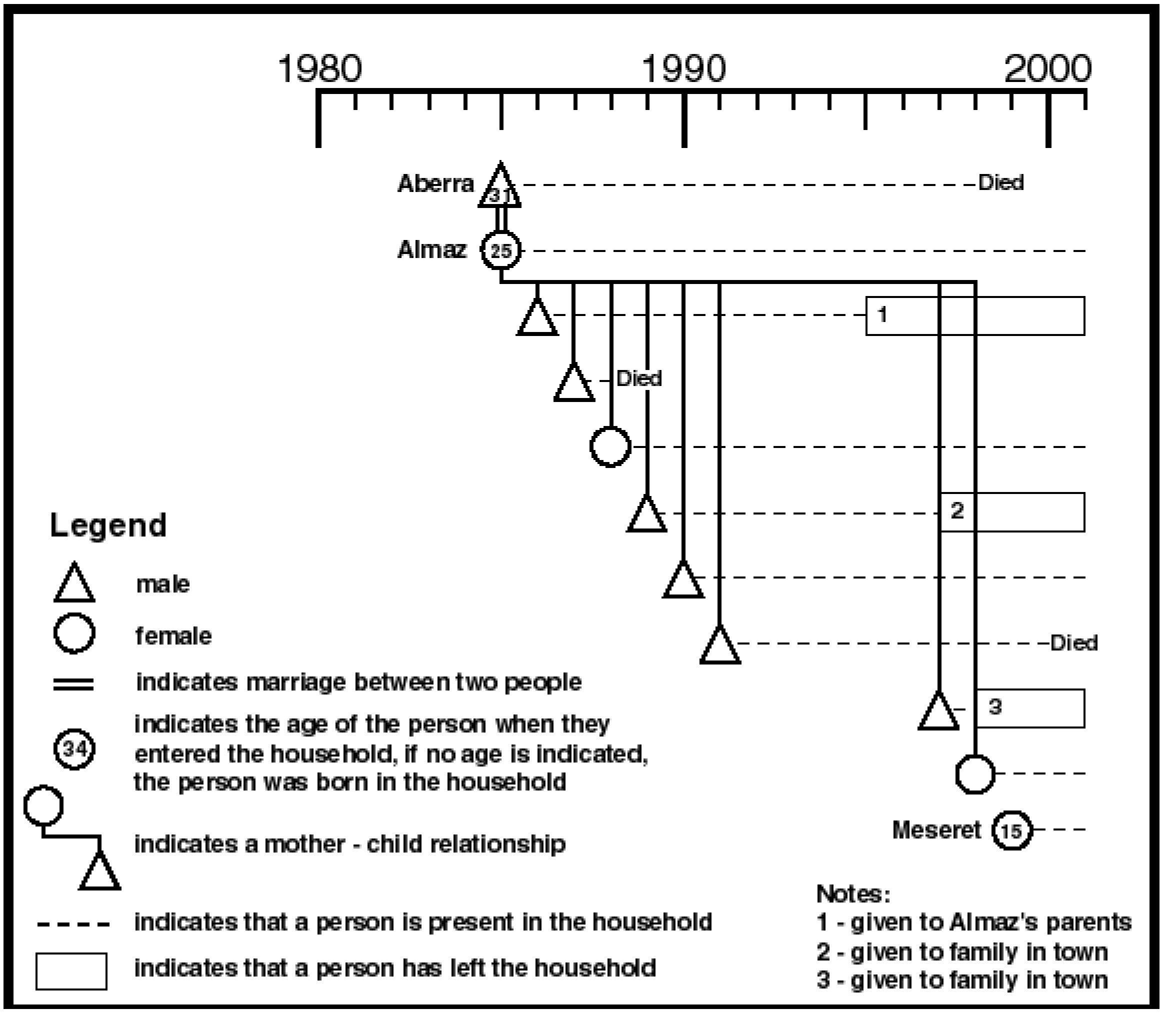
CASE STUDY

Script failure has a human face. The enset script directly links wealthier MHHs to generally poorer FHHs at the processing step of the script by wealthier households hiring often poor women within the community to process enset. Almaz, described in the case study below (Box 5), depends on a traditional Sidama patron-client relationship where she processes enset for her more wealthy neighbors, receiving enset in payment. The enset script's current failure affects most households that use the script, but this failure's effect on the poorest, at-risk households can be devastating. Although Almaz's household was not in a food secure position at the beginning of the narrative when her husband was alive, notice the shift in livelihood strategies from the categories of adaptive to coping to survival. Almaz's coping and survival strategies shift first from non-erosive disaccumulation to dangerous levels of erosive disaccumulation.

Box 5. Almaz.

Almaz was 25 when she and her husband Aberra were married in 1985. In the six years following their marriage, she had six children, five boys and one girl. They lost there second child, a boy, a year after his birth. Aberra tilled their small plot (0.12 ha), worked for neighbors, and found odd jobs in the nearby town. Almaz took care of their children, tended their two cows, and processed enset for several neighbors. During the first seven years of their marriage they never seemed to have anything extra, but they always had enough. However, Aberra started with a cough that never seemed to go away. In the beginning there were some days that he couldn't work, but as the cough grew worse, neighbors began to realize that they couldn't rely on him to plow or weed their plots as he once faithfully did. They had to sell one and finally their last cow to pay for doctors, medicine, and food. Almaz had always relied on processing enset for her neighbors to feed her family, but her neighbors called her less, complaining about how their enset fields were gradually shrinking. Their own enset field shrunk quickly during these difficult times. They sent their oldest son to live temporarily with Almaz's parents and another son to live with a family in town until things got better. After taking the medicine the doctor had given him, Aberra's cough eventually subsided and he slowly began to gain back his strength. After five years of sickness, during which time Almaz gave birth to no new children, she then had two more children, a boy and a girl about a year apart. Aberra worked long hours trying to earn enough money to buy back a cow, but everything he made seemed to go for buying food that Almaz had once been able to get from processing enset. Unexpectedly in 1998, Aberra became extremely sick with a fever and died a couple days later. Almaz, realizing that she alone must raise five children, gave her youngest son to another family in town at Aberra's funeral. Understanding Almaz's need for assistance, neighbors tried to call her more often to process enset, but dwindling numbers of enset plants in their fields made them unable to give her as much work as she needed. To help Almaz with all of the housework, her 15-year-old cousin Meseret came to live with her in 1999. Despite Meseret's help, they found it increasingly difficult to obtain enough food and care for the four children remaining at home. As a result, in 2000 her youngest son at home died suddenly with a fever only two years after her husband. Currently Almaz and Meseret continue to struggle to survive with Almaz's three remaining children, doing odd jobs and processing enset for neighbors as their primary sources of livelihood.

Figure 4. Almaz's household composition timeline



While her husband was alive and healthy, although they were virtually landless, poor, with few assets and not food secure, their household's activities were sufficiently diversified that they were able to make ends meet. As a poor family in the community, Almaz fed the family through a traditional patron-client relationship, processing enset for wealthier neighbors. However, these wealthier households had been continually harvesting enset heavily to cope with a recent string of grain crop failures and lower coffee prices. These short-term shocks were exacerbated by the longer-term process of soil fertility decline due to the loss of manure from reduced livestock numbers, causing enset to grow less vigorously. Without alternative sources of soil fertility improvement, even relatively wealthy households are unable to maintain enset production. This failure of the enset script highlights the need for its adaptation. The inability of wealthier households to modify the enset script to address the decline in soil fertility had a downstream effect on Almaz's household. The traditional patron-client relationship of outside enset processing that had always existed now no longer functions as effectively as it once had. Through these patron-client relationships, the soil fertility of wealthier households is indirectly related to the food security and well being of poor, almost-landless FHHs. The failure to address the soil fertility management aspect of the enset script affects both enset producing household and households that don't produce but process enset.

When Almaz's husband became sick, this triggered a chain reaction of asset erosion. Already poor and at risk, his sickness disrupted the household's precarious food security balance. His sickness led to the gradual reduction of his labor, his activities, and to livestock selling to cover the costs of treatment. The crisis of her husband's sickness and death forced the household into specialization (due to loss of husband's labor and skills) and Almaz sought to intensify her normal activity, enset processing. However, at the same time that she needed to intensify her activity of enset processing, wealthier neighboring households were facing severely reduced enset stocks and therefore requiring less outside enset processing. Not only had Almaz's household long ago consumed all of what little enset they had, but her wealthier neighbors had also severely reduced their enset stocks. First as a coping and then as a survival strategy, Almaz attempted to intensify the enset processing activity based on the failing enset script. Her coping and survival strategies, based on attempting to intensify enset processing, were tragically ineffective. As a result of the failure of these strategies, Almaz was forced first into non-erosive disaccumulation (selling cows, sending children away temporarily) and then into erosive disaccumulation (giving children away, cutting food consumption leading to dangerous levels of malnutrition). Almaz's problems had less to do with the shift from being a MHH to a FHH and the loss of adult male labor, etc. as it did with her continued reliance on intensifying an activity that couldn't be intensified (enset processing).

Both before and after her husband's death, Almaz's inability to diversify her livelihood activities was constrained by a number of factors. As a mother with young children at home, any activities that Almaz might undertake must allow her to work from her home. However, her limited skills and assets prevented her from engaging in potentially more lucrative craft activities. As a widowed woman with young children, Almaz is spatially constrained to her home. Few productive activities aside from enset processing are available in her community that meets her childcare constraints (enset processing for others permits her to bring her children to a neighbor's house). As a widowed rural woman, the prospects for migration are dim. How will she get access to more or better land, since remarriage for a widow is uncommon? What skills does she have that someone in a town would hire her? What initial capital does she have to start her own business? These are some of the factors that help explain the pressure FHHs commonly face and why they often do not remain female headed for long.

Almaz's oldest son, the likely successor to the land, is still living at home and is currently 11 years old (the two older sons given to a family in town are first in line, but are unlikely to be interested in returning to the land). In about ten years he will likely be interested in marriage and ready to inherit the land (assuming he is interested in farming rather than going off to town as is common). With few other options, rather than give up the little land and the home she has, Almaz believes she will try her best to manage until her oldest son at home is able to marry and take over the farm.

After her husband's death, Almaz's household was faced with a severe drop in male labor. This labor reduction is all that more dramatic when the number of mouths to feed is compared to Almaz's remaining labor. This relationship is commonly described using the consumer to producer (C/P) ratio (Chayanov, 1986).[68] Almaz's household composition timeline (Figure 4) was used to generate the C/P ratios in Figures 5 and 6. As its name implies, the C/P ratio is calculated by dividing the number of consumers by the number of producers. However, various factors can be multiplied to the numbers of consumers and producers to reflect the impact of these factors on the C/P ratio. The raw C/P ratio (using the raw number of consumers divided by the raw number of producers) appears as the blue line in Figure 5. Economists commonly multiply the raw number of consumers and producers by age and gender specific coefficients reflecting individuals' relative contribution to consumption and production (green line in Figure 5).[69] Dove calculated the ratio as the energy requirements of the consumers divided by the energy requirements of the producers to show the ratio in terms of human energy needs (the same can be done for protein).[70] World Health Organization human energy and protein requirements were used to calculate both the energy (red line) and protein (purple line) C/P ratios for Almaz's household found in Figure 6.[71]

Figure 5. Raw and coefficient consumer to producer ratios

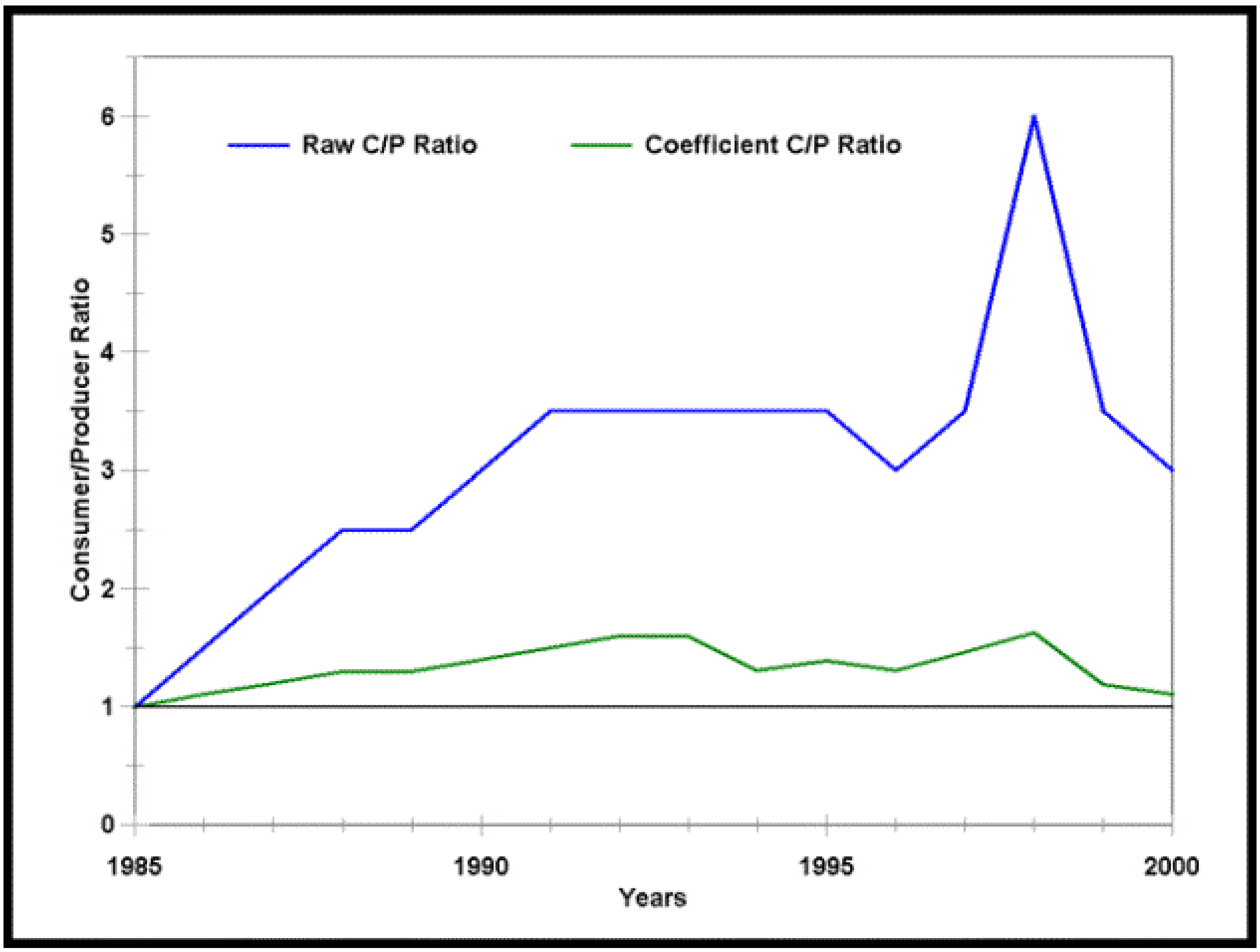
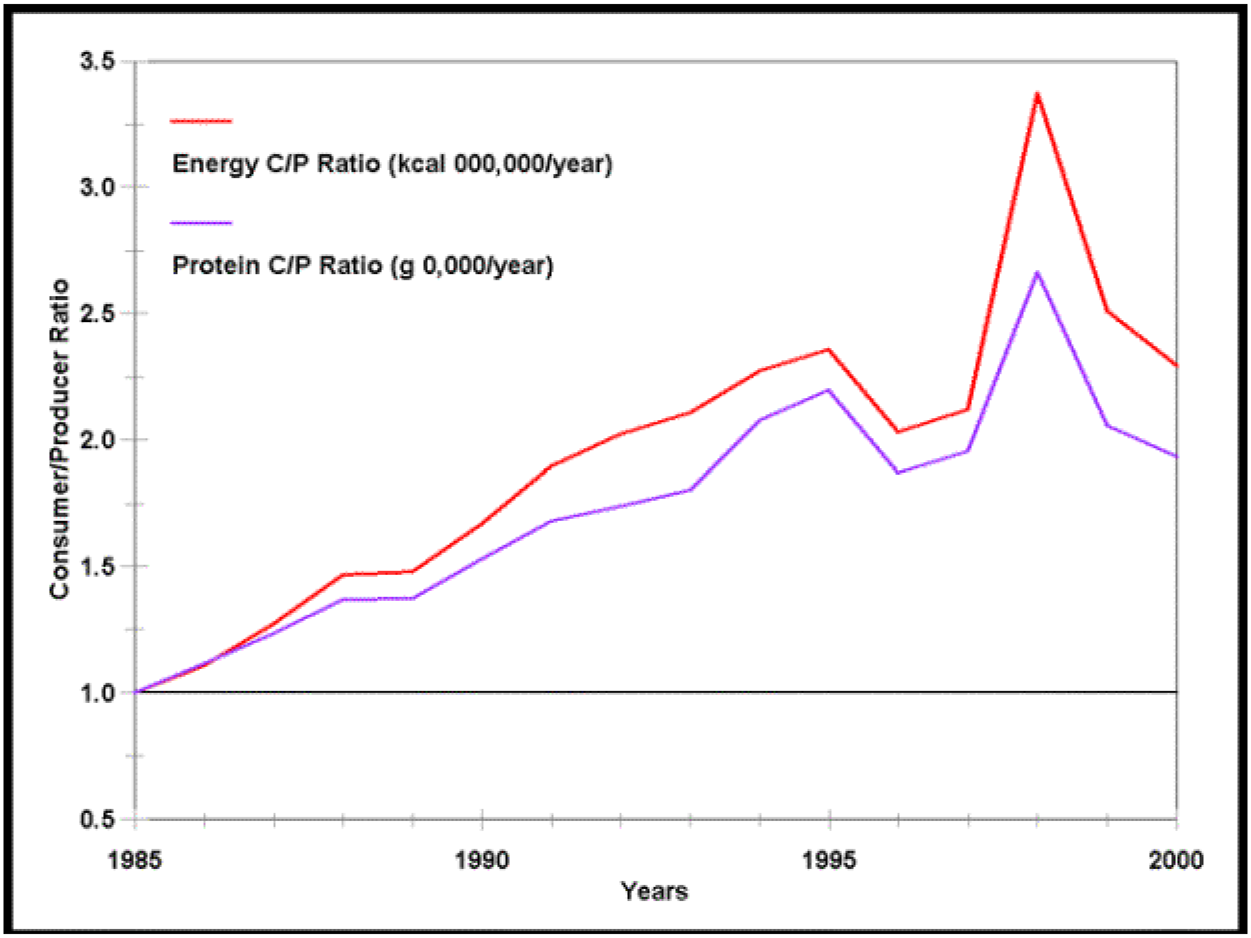


Figure 6. Energy and protein consumer to producer ratios



Once Almaz and her husband got married and started having children, all four C/P ratios began to rise as the number of consumers increased (more children) and the number of producers was static (2 parents). By the early 1990s there are 5 children under the age of 7 and only 2 parents. During this time the raw C/P ratio rises and levels off while the coefficient C/P ratio increases and then begins to decline due to their oldest daughter becoming old enough to help Almaz with housework. However, during the early 1990s the energy and protein C/P ratios continue to increase as growing young children require more food. In 1995 the effects of her husband's worsening illness begin to be reflected in the C/P ratios when they are forced to send their oldest son to live with her parents. The son's leaving positively affects all four of the C/P ratios, providing for a temporary decline in the C/P ratios after he leaves. Yet, despite sending a son away, as the children continue to grow (increasing the consumption side of the equation) so does the C/P ratio. In 1997, as one child is born, another is sent away, helping to keep down the C/P ratios. In 1998 when her husband dies a producer is lost and the C/P ratio jumps dramatically. The imbalance between consumption and production at this point is extreme.

With few other livelihood options, Almaz chose to bring in her young cousin Meseret to help. Notice the dramatic effect on the C/P ratios when she arrives in 1999. Faced with the inability to remarry, diversify, intensify, or migrate, Almaz chose to manipulate her household's composition to address the unsustainable imbalance between consumption and production.

With the addition of Meseret as another producer, the C/P ratios in most cases fall back to the levels before her husband died. Meseret will likely live with Almaz until she is ready to marry in about 5 years. However, Meseret's presence in the household will provide Almaz with the childcare assistance she needs until her youngest daughter is able to be home alone. When Meseret marries, that leaves only about 5 years before Almaz's oldest son remaining at home is ready to marry and take over the farm.

Household composition manipulation like Almaz's suggests that this type of coping and survival strategy may be more widespread in Sidama than previously considered. In this case study, household composition manipulation could clearly be classified as a survival strategy. However, instances can be identified where household composition manipulation could be considered accumulative, adaptive, or coping strategies.

SCRIPTS POINT TO HOW SOIL FERTILITY CAN BE IMPROVED

The existing enset script is failing and must be modified if the enset system is to continue to provide Sidama households with a food security livelihood. Everybody uses and follows scripts and Schank and Abelson point out that most human knowledge is contained in scripts.[72] Therefore, achieving changes in soil fertility management practices will not be possible without script modification. Script modification only occurs through the process of planning.[73] Expert farmers interviewed during this study are already doing extensive planning and testing to modify their scripts to meet existing conditions. The planning and testing that these experts have done has resulted in the development of successfully modified enset production and processing scripts. Based on interviews with non-expert farmers, these farmers are also capable of planning, but unlike experts, they need assistance undergoing the often arduous planning and testing process and require encouragement to successfully complete the script modification process. Scripts can be modified, but not outside this difficult process of planning and testing. Participatory action research can play an important role in helping farmers as they adapt their scripts to current conditions.[74]

Script documentation provides an important tool for linking farmer and scientific knowledge. The main purpose of documenting scripts is to help researchers understand the intricacies of farmer practice. Documenting scripts provides researchers with a systematic method for understanding how and why farmers do what they do. Scripts are an important gender analysis tool for systematically identifying who does what under what conditions. Scripts clearly identify key soil fertility management decisions that farmers must make. Scripts allow for the identification of the specific aspects of soil fertility management practice that is failing and those that are functioning effectively.[75] From these failing sections of scripts, decision trees can be developed for those crucial decisions to describe constraints and suggest opportunities for modification of farmer practice. Only after researchers understand these management practice intricacies are they able to apply the scientific body of knowledge appropriately to a farmers' given context.

The enset script presented here can be used as an example of this suggested process. The critical point where the enset script currently fails is in maintaining the soil fertility of enset land when households cannot keep large numbers of livestock. The logic of the script depends on vigorous enset growth. Low soil fertility, due to the severe reduction in manure, reduces the vigor of enset growth. Repeated decisions deal with the application of manure and more recently to the use of inorganic fertilizer. Script documentation is necessary for researchers to understand the answers to questions such as: What are the decision criteria for these critical decisions? How are these decisions structured? Only after researchers are familiar with farmer management practice are they ready to assist farmers with ideas on alternative production practices that meet their household's constraints.

Based on case study interviews, farmers report that depressed coffee prices, recent poor coffee harvests, slumping eucalyptus pole demand (following the post-1992 revolution building boom), limited fertilizer availability, and unavailability of credit makes even the limited use of inorganic fertilizers on enset extremely unlikely in the near future. Sixty-five percent of households claim that grazing land shortage is the largest constraint to keeping more livestock.[76] Farmers lament the loss of livestock (primarily cows, 93% of households keep cows) but are unfamiliar with the various techniques for intensifying fodder production necessary for keeping livestock on less land (88.4% do not store hay for the dry season). Given the current problems associated with obtaining inorganic fertilizer and since farmers want to keep more cows (40.4%), it seems that intensification of livestock production appears to be the most promising approach (best-bet) for modifying the enset script to maintain the soil fertility of enset land and allow enset production to remain viable.

This researcher-derived starting point, based on a best-bet approach, should serve as the initial input into a farmer-driven planning process. Discussions with farmers can begin with analyzing the feasibility of various fodder production techniques. Lessons learned from expert farmer planning may serve as a guide for non-expert farmers during the process. As farmers progress through the planning process, testing should follow. Work with farmers should be done to test the various fodder production techniques farmers think appropriate.[77] The role of the facilitating organization should be to encourage and assist the farmers through the planning and testing process. The process suggested here is not new, but is implemented with standard farming systems research and extension and participatory methodology.[78] The only new aspect of this process suggested here is the introduction of scripts as a methodology for systematically organizing the information typically gathered about farmer management practices. Due to the systematic rigor necessary to build a coherent script, script documentation helps organize data on farmer practice that might otherwise be lost among the mass of project data commonly gathered.

This process may seem long, complicated, and impractical on a large scale compared to existing agricultural extension practices. However, effecting changes in soil fertility management practices requires a process of learning and adaptation by the farmer. The process may seem tedious, but people's cognitive processes cannot be ignored or rushed. Continued failure to address the planning, adaptation, and learning aspects involved in changing farmer soil fertility management practices in agricultural extension will lead to continued project failure.

SUMMARY

This paper has claimed that population growth has led to the reduction in grazing land and has therefore caused a reduction in the number of livestock (primarily cattle) held by each household.[79] The reduction in household livestock numbers has led to the reduction of manure applied to enset plants that require regular soil fertility amendments to support vigorous enset growth.[80] Without vigorous enset growth, the logic of the enset script fails. These FHHs, who often depend on their wealthier neighbors for processing enset to remain food secure, suffer when the enset production of wealthier households declines. The process described in the case study presented here serves as an indicator pointing to the need for enset script modification.

This paper has discussed men and women's production roles, the gender division of labor, the gender division of skills and cultural knowledge, and gendered access to capital within the enset system. This author feels that the discussion of these issues is necessary to understand the relationship between the process of soil fertility decline and households' choice of livelihood strategy. Data on enset production and processing scripts has been analyzed within this framework. The case study of a FHH presented here has shown that the food security of this household, through the livelihood strategies it choose, integrates it into a community-wide process of enset land soil fertility decline. Understanding the connection between the process of soil fertility decline and choice of enset-based livelihood strategies that this case study illustrates is necessary for the design of effective food security policy in the Sidama Zone.

Farmers report that the old ways of doing things (represented by the enset script documented here) are no longer able to meet their household food security and other objectives. Some farmers are engaged in modifying the enset script, searching for new ways to maintain the fertility of enset fields (intensification), while others are trying new combinations of livelihood activities (diversification) to achieve food security. However, most farmers seem understandably slow to adapt in the face of the bewildering changes they have experienced during the Twentieth Century. The large majority of farmers need assistance to undertake the planning and testing necessary to modify the scripts on which they depend for food security.

Soil fertility research must move beyond just technical feasibility assessments; ultimately farmers must decide what mix of soil fertility improvement technologies work within their livelihood system.[81] Many soil fertility improvement programs in Ethiopia (and elsewhere) have failed partly as a result of not considering how these technologies fit within the complex contingencies involved in various household livelihood strategies. [82] To address this deficiency, scripts are suggestive of ways that various soil fertility improvement technologies could be incorporated into existing livelihood strategies with the greatest likelihood of adoption. Rather than national or non-governmental organization (NGO) extension staff designing regional soil fertility improvement technology adoption programs as is the norm, it is concluded that since farmers have traditionally developed and use scripts to manage soil fertility, the farmers themselves should be involved in the participatory planning and testing of alternative scripts to improve soil fertility. It is argued that farmer-developed scripts that incorporate soil fertility improvement technologies will more likely "fit in" with the rest of the household livelihood strategy better and will therefore be more successful than the more common region-wide, blanket soil fertility improvement programs.

Notes

1. Due et al.,1998; Due & Gladwin1996; Verma, 2001
2. Scoones, 1998; Ashley, 1999; Brock, 1999; Turton, 2000; Farrington, 2001

3. Scoones, 1998
4. Schank and Ableson, 1977
5. Degife, 2001
6. The Sidama Zone is composed of nine administrative districts called *woredas* (Amharic). Each of these nine *woredas* contains lowland, midland, and highland areas. Three peasant associations (the next administrative level below *woreda*) were randomly selected within each of a *woreda's* lowland, midland, and highland areas. Ten households were selected randomly from each peasant association list. To examine FHH food security regionally, at least one FHH was chosen from each peasant association, thus ensuring that al least 10% of the sample is composed of FHHs. 9 *woredas* x 3 agroecological zones x 10 households = 270 households.
7. Schank & Abelson, 1977, p.41
8. Chayanov, 1986; Haddad et al., 1997
9. Campbell, 1999
10. Gladwin & Butler, 1984; Gladwin, 1984
11. Hussein & Nelson, 1998
12. Decron & Krishnan, 1996
13. Devereux, 1999
14. Devereux, 1999, p. 8
15. Due to the poverty focus of the livelihoods literature the more vulnerable, dis-accumulative end of the continuum has been conceptually more developed than the better-off, accumulative end.
16. Devereux, 1999
17. Hussein & Nelson, 1998
18. Locality is perhaps a better term for this spatial dimension, rather than the term migration that refers to a particular strategy.
19. Devereux, 1999; Decron, 2001
20. Devereux, 1999
21. Ibid.
22. Degife, 2001
23. Gamachu, 1977; SZPEDD, 1997
24. Smeds, 1955; Huffnagel, 1961; Shack, 1963; Westphal, 1975; Kefale & Sanford, 1991; Tsedeke et al., 1996
25. Brandt et al., 1997
26. Kefale & Sanford, 1991; Endale et al., 1996
27. Kelbessa et al., 1996; Spring et al., 1996
28. Ayele & Berhanu, 1996
29. Werner & Schoepfle, 1979
30. Kefale & Sanford, 1991; Gebre, 1995; Spring et al., 1996
31. The English terms used in Box 1 for the stages of enset growth refer to the typical age of plants in mid-altitude areas (woinadega). Enset growth appears to be largely temperature dependent, since plants mature in low-altitude areas (qola) in approximately 4 to 6 years, mid-altitude areas in approximately 6 to 8 years, and in

high-altitude areas in approximately 10 to 12 years. Since the schema of stage names in mid-altitude and high-altitude areas (dega) is the same, it therefore seems that stage is based more on size than on age (Clifton Hiebsch, personal communication). That the length of each of the stages presented here is approximately one year is a convenient coincidence caused by the rate of enset plant growth in mid-altitude areas, not an emic characteristic of each stage. If lengths of time were given based on interviews from low-altitude and high-altitude areas, the time would likely be shorter and longer respectively. Etic characterizations of enset stages are based on estimations of enset plant size (clone dependent girth and height, spatial relation to neighboring plants, etc.) that outsiders have difficulty understanding. Plant age is used here for simplicity.

32. The Sidamic terms of stage names are placed in parentheses following the English description of the stage.
33. Westphal, 1975; Getahun & Tenaw, 1990
34. Westphal, 1975
35. Brandt et al., 1997
36. Kefale & Sandford, 1991
37. Smeds, 1955; Westphal, 1975; Dessalegn, 1996; Hiebsch, 1996
38. ENI, 1981
39. Dessalegn, 1996; Quimio & Mesfin, 1996
40. Tibebu et al., 1994
41. McCabe, 1996
42. Ibid.
43. Befkadu & Berhanu, 2000; Getachew, 1995
44. Smeds, 1955; Shack, 1963; Brandt, 1996; Tsedeke et al, 1996
45. Dessalegn, 1996
46. Degife, 2001
47. Smeds, 1955; Raya, 1988; Getahun & Tenaw, 1990; Alemayehu et al., 1995; Bull et al., 1995; Spring et al., 1996; Degife, 2001
48. Asnaketch, 1996
49. Degife, 2001
50. Ibid.
51. Ibid.
52. Joireman, 2000
53. Nine percent of households struggle with identifying a successor which is suspiciously close to the 10% of FHHs (Degife, 2001).
54. Tibebu et al., 1994
55. Tibebu et al., 1994; Spring et al., 1996
56. Shaqisha is another type of enset processing (not discussed here for simplicity) intended for rapid maturation and early consumption of enset products before products from the primary processing (hassa) have matured.
57. 57.Gladwin & Butler, 1994; Werner & Schoepfle, 1979
58. Schank & Abelson, 1977
59. Spring et al., 1996; Brandt et al., 1997

60. One hundred plants was chosen since this is the number of plants processed in the now common small primary processing (small hassa).
61. Befekadu & Berhanu , 2000, p. 1-3
62. Ibid., p. 52-59
63. Ibid., p.85
64. Ibid., p.59-62
65. Degife, 2001
66. Ibid.
67. See Dessalegn, 1996 and Tibebu, Sanford, and Kindness, 1994 for a description of this process in neighboring Woliata.
68. When the number of consumers is higher than the number of producers (C/P ratio <1), th e household is under stress. When the number of consumers and producers are the same (C/P ratio =1), the household is in a good position. If the number of consumers is less than the number of producers (C/P ratio <1), a situation where outside household members that are not consuming send remittances, the household is in an excellent position.
69. The coefficients found in Tables 7 and 8 were used in the calculation of the coefficient consumer producer ratio found in Figure 5.

Table 7. Consumer units

Age categories	Male coefficient	Female coefficient
0 to <6	0.2	0.2
6 to <12	0.4	0.4
12 to <16	0.5	0.5
16 to <35	1.0	1.0
35 to <50	1.0	1.0
>50	0.8	0.8

Table 8. Producer units

Age categories	Male coefficient	Female coefficient
0 to <6	0.0	0.0
6 to <12	0.0	0.6
12 to <16	0.5	1.0
16 to <35	1.0	1.0
35 to <50	1.0	1.0

>50	0.8	0.8

70. Dove,1984
71. World Health Organization, 1985
72. Schank & Abelson, 1977
73. Ibid.
74. Sutherland & Sanford 1999a; Sutherland & Sanford 1999b
75. 75.Gladwin & Butler, 1984
76. Degife, 2001
77. Sutherland & Sanford 1999a; Sutherland & Sanford 1999b
78. Hildebrand, 1986; Chambers, 1997
79. McCabe, 1996
80. Asnaketch, 1996
81. Chambers, 1997
82. Yeraswork, 2000

References

Alemayehu K., M. Bull, and Aberra M. 1995. *Report of Diagnostic Survey Using Rapid Rural Appraisal Techniques of Galla Argessa Peasants Association in Awassa Zuria Wereda*, FARM Africa, Addis Ababa, Ethiopia.

Ashley, C. 1999. *Applying Livelihood Approaches to Natural Resource Management Initiatives: Experiences in Namibia and Kenya* . London: Overseas Development Institute.

Asnaketch W.T. 1996. Nutrient Circulation within Enset Growing Farms in Two Regions of Ethiopia. Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 287-297. Addis Ababa: Institute of Agricultural Research.

Ayele Nigatu, and Berhanu Abegaz Gashe. 1996. Inhibitory activity of fermented kocho on spoilage and pathogenic bacteria. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 321-27. Addis Ababa: Institute of Agricultural Research.

Befekadu Degife, and Berhanu Nega, Eds. 2000. *Annual Report on the Ethiopian Economy: 1999/2000.*, Vol. I. Addis Ababa: The Ethiopian Economic Association.

Brandt, S.A. 1996. A Model for the Origins and Evolution of Enset Food Production. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 36-46. Addis Ababa: Institute of Agricultural Research.

Brandt, S.A., Spring, A., Hiebsch, C., McCabe, T.J., Endale Tabogie, Mulugeta Diro, Gizachew Wolde-Michael, Gebre Yntiso, Masayoshi Shigeta, Shiferaw Tesfaye. 1997. "The 'Tree Against

Hunger'." Web page, [accessed 14 February 2002]. Available at http://www.aaas.org/international/ssa/enset/.

Brock, K. 1999. *Implementing a sustainable livelihoods framework for policy-directed research: reflections from practice in Mali*. IDS Working Paper 90. Brighton: IDS.

Bull, M., Alemayehu K., and Endalkatchew W. M. 1995. *Report of Diagnostic Survey Using Rapid Rural Appraisal Techniques of Bashilo Dalo Peasant Association in Arbegona Wereda*, FARM Africa, Addis Ababa, Ethiopia.

Campbell, D. J. 1999. Response to Drought Among Farmers and Herders in Southern Kajiado District, Kenya: A comparison of 1972-1976 and 1994-1995. *Human Ecology* 27, no. 3: 377-416.

Chambers, R. 1997. *Whose Reality Counts?* London: Intermediate Technology Publications.

Chayanov, A. V. 1986. Peasant Farm Ogranization. In *The Theory of Peasant Economy.* Eds. D. Thorner, B. Kerblay, and R. E. F. Smith. Madison, Wisconsin: University of Wisconsin Press.

Degife Shibru. 2001. *Present and Future Status of Sidama Food Security: Sidama household level food security survey*. Awasa, Ethiopia: Chiba Development Consulting Firm.

Dercon, S. 2001. *Income risk, coping strategies and safety nets*. Oxford: Centre for the Study of African Economies (CSAE).

Dercon, S., and P. Krishnan. 1996. Income Portfolios in Rural Ethiopia and Tanzania: Choices and Constraints. *Journal of Development Studies* 32, no. 6: 850-875.

Dessalegn R. 1996. Resilience and vulnerability: enset agriculture in Southern Ethiopia. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 83-104. Addis Ababa: Institute of Agricultural Research.

Devereux, S. 1999. *Making Less Last Longer: Informal Saftey Nets in Malawi, IDS Discussion Paper 373*. Brighton: Institute of Development Studies.

Dove, M. R. 1984. The Chayanov Slope in a Swidden Society: Household demography and extensive agriculture in West Kalimantan. In *Chayanov, Peasants, and Economic Anthropology*. Ed. E. P. Durrenburger, 97-132. Orlando, Florida: Academic Press.

Endale T., Mulugeta D., and Bezuayehu H. 1996. Enset Improvement Research: Past and Present. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 228-34. Addis Ababa: Institute of Agricultural Research.

ENI. 1981. *Expanded food composition table for use in Ethiopia*. Addis Ababa: Ethiopian Nutrition Institute.

Farrington, J. 2001. Sustainable livelihoods, rights and the new architecture of aid. *ODI Natural Resource Perspectives*, Number 69. London: Overseas Development Institute.

Gamachu, D. 1977. *Aspects of Climate and Water Budget in Ethiopia*. Addis Ababa University Press, Addis Ababa, Ethiopia.

Gebre Y. 1995. "The Ari of Southwestern Ethiopia: An exploratory study of production practices." Social Anthropology Dissertation Series, No. 2, Addis Ababa University.

Getachew Diriba. 1995. *Economy at the Crossroads: Famine and food security in rural Ethiopia*. Addis Ababa: Care International.

Getahun D., and Tenaw W. 1990. *Initial Results of Informal Survey: Areka Area Mixed Farming Zone, Welayita Awraje, Sidamo Region*, Institute of Agricultural Research, Addia Ababa, Ethiopia.

Gladwin, C. H. 1984. Who does the garden work? *Proceedings of the Florida State Horticultural Society* 97: 230-235.

Gladwin, C. H., and J. Butler. 1984. Is gardening an adaptive strategy for Florida family farmers? *Human Organization* 43, no. 3: 208-16.

Haddad, L., Hoddinott, J., and Alderman, H., Eds. 1997. *Intrahousehold Resource Allocation in Developing Countries: Models, Methods, and Policy.* Baltimore: Johns Hopkins University Press.

Hiebsch, C. 1996. Yield of *Ensete ventricosium* - A Concept. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 15-35. Addis Ababa: Institute of Agricultural Research.

Hildebrand, P. E. 1986. *Perspectives on farming systems research and extension*. Boulder, Colorado: Lynne Rienner Publishers.

Huffnagel, H. P. 1961. *Agriculture in Ethiopia*. Rome: FAO.

Hussein, K., and Nelson, J. 1998. *Sustainable livelihoods and livelihood diversification*. IDS Working Paper 69. Brighton: Institute of Development Studies.

Joireman, S. F. 2000. *Property Rights and Political Development in Ethiopia and Eritrea*. Oxford: James Curry.

Kefale A., and Sanford, S. 1991. *Enset in North Omo Region*. Farmer Participatory Research Technical Pamphlet No. 1. Addis Ababa, Ethiopia: FARM Africa.

Kelbessa Urga, Ayele Nigatu, and Melaku Umeta. 1996. Traditional Enset-Based Foods: Survey of processing techniques in Sidama. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds.

Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 305-14. Addis Ababa: Institute of Agricultural Research.

McCabe, T. 1996. The Ecological and Cultural Significance of Livestock in the Enset Agricultural Complex. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 53-68. Addis Ababa: Institute of Agricultural Research.

Quimio, A. J., and Mesfin T. 1996. Diseases of Enset. In *Enset Based Sustainable Agriculture in Ethiopia.* Eds. Tsedeke A., C. Hiebsch, S. A. Brandt, and Seifu G.M., 188-203. Addis Ababa: Institute of Agricultural Research.

Raya A. 1988. *Sidama Mixed Farming Zone Diagnostic Survey Report: Sidamo Region*, Institute of Agricultural Research, Addis Ababa, Ethiopia.

Schank, R. C., and Abelson, R. P. 1977. *Scripts, Plans, Goals and Understanding: An inquiry into human knowledge structures*. New York: John Wiley & Sons.

Scoones, I. 1998. *Sustainable Rural Livelihoods: A Framework for Analysis, IDS Working Paper 72*. Brighton: Institute of Development Studies.

Shack, W. A. 1963. Some Aspects of Ecology and Social Structure in the Enset Complex in South-west Ethiopia. *Journal of the Royal Anthropological Institute* 93: 72-79.

Smeds, H. 1955. The Ensete Planting Culture of Eastern Sidamo, Ethiopia. *Acta Geographica* 13: 2-39.

Spring, A., Admasu T., Asnaketch W.T., Assefa A., Bekalu M., Bezuayehu H., Endale T., Gizachew W.M., Ousman S., Seble S., Shiferaw T., Tariku M., Tesfaye H., Tesfaye T., and Yewelsew A. 1996. *Enset Farming Systems in Southern Region, Ethiopia: Report on Rapid Rural Appraisal in Gurage, Hadiya, and Sidama Zones*, Phase I Report, GTZ Enset Needs Assessment Project, Awassa, Ethiopia, Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)

Sutherland, A., and Sanford, S., Eds. 1999a. *Incorporation of Farmer Participatory Research in the Southern Region of Ethiopia: Proceedings of a workshop held in Awasa, 18-19 March 1998*. Addis Ababa: FARM Africa and the Institute for Sustainable Development.

Sutherland, A., and Sanford, S., Eds. 1999b. *Review of Experiences with Participatory On-Farm Trials in the Southern Region of Ethiopia: Proceedings of a workshop held in Soddo, 17-18 May 1998*. Addis Ababa: FARM Africa and the Institute for Sustainable Development.

SZPEDD. 1997. *Sidama Administrative Zone: A Socio-Economic Profile*. Awasa, Ethiopia: Sidama Zone Planning and Economic Development Department.

Tibebu H.W., Sanford, S., and Kindness, H. 1994. "The Age and Sex Structure of Enset Plantations in North Omo." *Gender, Structure and Landraces in Peasant Enset Plantations in North Omo*, (Ed.) S. Sanford. FARM Africa, Addis Ababa, Ethiopia.

Tsedeke, A., Hiebsch, C., Brandt, S. A. and Seifu G.M., Eds. 1996. *Proceedings of the International Workshop on Enset*, 15-35. Enset Based Sustainable Agriculture in Ethiopia, Addis Ababa, Ethiopia: Institute of Agricultural Research.

Turton, C. 2000. *Sustainable Livelihoods and Project Design in India*. London: Overseas Development Institute (ODI).

Verma, R. 2001. *Gender, land, and livelihoods in East Africa: through farmers' eyes*. Ottawa, Canada: International Development Research Centre.

Werner, O. and Schoepfle, G.M. 1979. The Handbook of Ethnoscience: Ethnographics and Encyclopaedias. Evanston, Illinois: Department of Anthropology, Northwestern University.

Westphal, E. 1975. *Agricultural Systems in Ethiopia*. Wageningen, Netherlands: Centre for Agricultural Publishing and Documentation.

WHO. 1985. *Energy and Protein Requirements.* Geneva: World Health Organization.

Yeraswork Admassie. 2000. *Twenty Years to Nowhere: Property rights land management and conservation in Ethiopia*. Lawrenceville, New Jersey, USA: Red Sea Press.

Reference Style: The following is the suggested format for referencing this article: Dougherty, Michael. "Gendered Scripts And Declining Soil Fertility In Southern Ethiopia." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a5.htm

Gender, Household Composition, and Adoption of Soil Fertility Technologies: A Study of Women Rice Farmers in Southern Senegal

AMY J. SULLIVAN

Introduction

If as claimed by the Food and Agriculture Organization of the United Nations women grow up to eighty percent of the food produced in Africa, then targeting them during research, technology development and dissemination makes sense. [1] In order to do so, it is necessary to recognize that not all women farmers are the same with respect to their access to resources, or their goals and motivation. This research shows how an additional factor—household composition—can determine which subgroups of women farmers can adopt technologies aimed at increasing their productivity, under what conditions.

Adoption by farmers is the ultimate test of research and technology in agricultural development, and should be the ultimate goal as well. To meet this goal these processes need to be designed and carried out with end users in mind. This means understanding the target audience before researching and developing new technologies. In Africa, this means focusing on women farmers and understanding their livelihood options and resource allocation decisions. In addition, it means exploring household composition as a key factor that can increase or decrease the likelihood of adoption of technologies by women farmers.

Smallholder farmers manage factors of production—land, labor, and capital—under conditions where the only constant is change. Better than anyone, they are able to identify and explain the defining variables, or drivers, of these seemingly unpredictable and diverse systems. [2] The keys to discovering and decoding diversity lie with the farmers, men and women, and are often hidden within their objectives and motivation.

Diversity in livelihood activities, or systems, examined at the national level may indicate activities chosen based upon biophysical, ecological or policy differences. Diversity between livelihood systems at the community or regional level may indicate strategies chosen based upon cultural differences. [3] Diversity among households within the same livelihood system can indicate livelihood strategies chosen based upon household composition, a determinant of labor availability and consumption requirements. Thus efforts to improve conditions in any system must begin with an awareness of what exists, where farmers want to be, which avenues fit within their norms and are acceptable to them, and what resources their households can devote to these endeavors. [4] In this case, livelihood systems are defined as the range of activities to which a household has access in the effort to meet their needs, while livelihood strategies are the specific resource allocation decisions made by each household over time.

http://www.africa.ufl.edu/asq/v6/v6i1-2a6.pdf

ISSN: 2152-2448

This research was undertaken to understand the nature and specifics of livelihood systems of Fulbe farmers in southern Senegal and their strategies, practices, and activities. [5] The following case study illustrates that once a specific livelihood system is delineated, there remains a range of activities women farmers have available to them. It then illustrates the role of household composition in determining livelihood strategies pursued by women farmers. Finally, this paper suggests that to correctly identify and effectively address the needs of women farmers, each member of the development community (policy makers, researchers, and field workers) must work with them in mind.

GENDER

When examining livelihood strategies in subsistence farming systems in Africa, a distinct and crucial element of decision making is gender. Oakley declares that "Gender differences . . . arise from the socially constructed relationship between men and women." [6] The nature of these relationships varies greatly by culture and social system, and serves to create distinct roles and responsibilities often referred to as gender roles or gender division of labor. These distinctions are shaped by various environmental factors including ideological, religious, economic and cultural factors; and help define resource allocation and access between men and women. [7]

The Women in Development (WID) literature explains how women in developing countries (farmers, workers, and business people) are often 'invisible', and as such their contribution to the household as a production unit is often ignored, overlooked or underestimated by observers. [8] Misrepresenting women's role in the household leads to misunderstanding of decision making within the unit. This situation is perpetuated by development professionals who collect data based upon a person's perceptions of his or her role within the household rather than their actual participation in activities. [9] In this case, women often refer to their husbands as the primary producers and themselves as only supporting the household. As a result, women's participation is grossly underreported or misunderstood and development efforts ignore a major group of producers. [10]

RESEARCH SETTING

Field research was done in a small community of subsistence farmers in the Upper-Casamance region of southern Senegal. In many ways, this particular area does not resemble Senegal north of the Gambia or areas closer to the coast, and has not been studied to the same degree as those areas. For example: in biophysical terms, rainfall is higher in the south; economically speaking, incomes tend to be higher in the north; and in terms of ethnicity, Wolofs and Sereers are the majority in the north but few live south of the Gambia. This diversity is reflected in the slight-to-nonexistent connection that this area has to political institutions in Dakar and resulting infrastructure and development.

The Upper-Casamance is considered tropical with one rainy season from July through November. In a typical year the region receives 1000 mm of rain with August and September being the wettest months. The dominant geographical feature in this area—the Department of

Kolda—is the Casamance River. Villages in the valley are agrarian in nature and rely on the river for water for their livestock, fishing, some transport, market gardens, and occasional dry season rice plots. Several ethnic groups inhabit this area including the Fulbe, Mandinka, and Diola. Polygyny is an accepted practice in this predominantly Muslim region. [11]

Subsistence farmers in southern Senegal produce most of what they eat (cereal grains, legumes and vegetables) and have limited access to cash for the purchase of food or other inputs. Their diet consists mainly of rice, maize and millet as staples accompanied by various sauces based upon locally produced groundnuts, hibiscus leaves, and okra. In addition to food crop production activities, various domestic or constant household tasks consume the scarce resources of these villages and households. Land tenure is communal with male village elders deciding which households have access to which areas of land. Households are assigned areas of upland fields for production of maize, millet, sorghum, and groundnuts to be cultivated at the discretion of the male head of household. Each household is also assigned areas suitable for rice production, to be cultivated at the discretion of the senior women in the household. Limited labor—rather than land scarcity—typically prevents men and women from expanding their cultivated areas.

Men in this area are responsible for producing upland cereal grain and pulse crops while women typically focus on rice, specialty crops, and virtually all domestic activities of the household. Staple grains produced in this area include rice, millet and maize while groundnuts are the most widely grown cash crop. Men often opt to work with male relatives to cultivate communal maize or millet but rarely share labor or cash benefits of groundnut production. Many farmers, usually women, produce specialty crops—mostly vegetables—for home consumption and market. The limited use of animal traction and a distinct division of labor with respect to crop production characterize this system.

Fulbe farmers in this region have limited access to cash generating activities. Men typically produce groundnuts as their main income generating activity while women often have no regular source of cash income. This low level of commercialization is more typical of local Fulbe than other local ethnic groups whose production activities are typically more diversified.

Perhaps the most crucial aspect of food security in this region is the fact that food security is ultimately communal; no one in the village starves if someone in the village still has food or resources. Households are expected to produce for and feed themselves, but in the event of crop failure, food shortage, or extraordinary stress, the village will pool resources and adopt village strategies for survival. In the event of food scarcity, Fulbe may slaughter or sell livestock to survive stressful periods.

LIVELIHOOD SYSTEMS

The main agricultural activity of Fulbe women is rainfed rice production, done entirely by hand without the benefit of mechanization or hired labor. Women's performance of this activity is crucial to them, not only for food security, but because they derive prestige among their peers from being superior rice producers. As such, in the eyes of the community, their main contribution to the household is the quantity and quality of rice they are able to provide. These women each work their own rice plots, from soil preparation through harvest, and prepare the rice as meals for their families. When a woman's rice runs out, she must cook millet, or rice bought by her husband. Her perceived inadequacy is noticed within the village, especially if other women (co-wives) in her household are still preparing rice they have produced.

The intrinsic value attached to rice encourages these women to devote most of their rainy season labor to this activity and not invest significant time in other agricultural activities, such as vegetable or groundnut production. Rice takes on greater importance for Fulbe women as the only staple that they control completely. Fulbe men distribute other food—millet, maize, sorghum and groundnuts—to women for daily preparation without consideration of budgeting. Ultimate responsibility for ensuring that households eat at culturally acceptable levels falls to the men; and they must make up for any production (cereal grain) shortfalls during the year. Women are expected to grow rice and secure items for relish but are not expected to have cash to contribute toward the purchase of food. There exists a rigid division of labor between men and women and very few production or domestic activities are shared within the household unit.

HOUSEHOLD COMPOSITION

Examination of households within a village may show similarities in livelihood systems, natural resource availability, ecological conditions, constraints and even culture; but this can be misleading. Within any community, each household is distinct due to variations in resource availability and consumption requirements as determined by its composition at any given point in time. Households consist of individuals, each of whom require of and contribute to the household at differing levels as they age. Thus, no two households will have either the same exact needs or the same exact resources with which to meet them. This diversity necessitates complex resource allocation decisions, and these households persist by adopting complex and diverse strategies to exploit available resources. [12] Many of these strategies are based upon manipulation of their own labor to meet their objectives, which range from reproduction of the family unit without regard to profit maximization to profit maximization. [13] Not only does composition determine resource availability and consumption but also determines which livelihood strategies can be pursued and to what degree. This is especially true within livelihood systems with distinct gender divisions of labor.

Given that individual households in the study area undertake production activities as a unit, they rarely hire labor and seldom exchange labor. Thus their stage in the development cycle, or their structure, determines their supply of labor at a given point in time. As households age, a series of changes likely takes place; initially children are born into the household directly claiming women's time as childcare providers and indirectly claiming men's time via increased food demand coupled with reduced female production labor. As children mature, their labor is consumed as available; boys begin helping with livestock care and fieldwork while girls typically begin performing household tasks such as childcare, food preparation, and cleaning. At some point male heads of household may opt to take an additional wife. Her addition to the household immediately increases labor available for rice production and/or reproduction activities. Eventually, household heads begin planning for one of their children (usually male) to marry and stay in the village to support his parents as they age. In the event there are several male children in the household, one or more may opt to leave his home village, at marriage, in search of new land to cultivate.

LIVELIHOOD STRATEGIES AND HOUSEHOLD STRESS

As household members age—regardless of sex—their roles and responsibilities to the household change, as well as their nutritional requirements. Previous studies have examined the effects of changes in household composition and suggest that among these changes, reproductive demands influence women's involvement in production activities. [14] These studies consider how pregnancy, childbirth, and lactation influence the amount and quality of labor a woman can devote to production tasks. Although cases from Latin America suggest that husbands and older children often share in child care responsibilities and that women are inclined to take their small children to the fields, the number and ages of the children dependent on a woman may impact her ability to work. [15] Consequently, every household will experience some degree of stress due to changing demographics in the household, especially in cultures where men are rarely involved in childcare. A household must adopt various livelihood strategies over its lifetime based upon the amount and quality of labor—the supply side—as determined by the number of members present and their ability. Consumption requirements—the demand side—also help determine livelihood strategies.

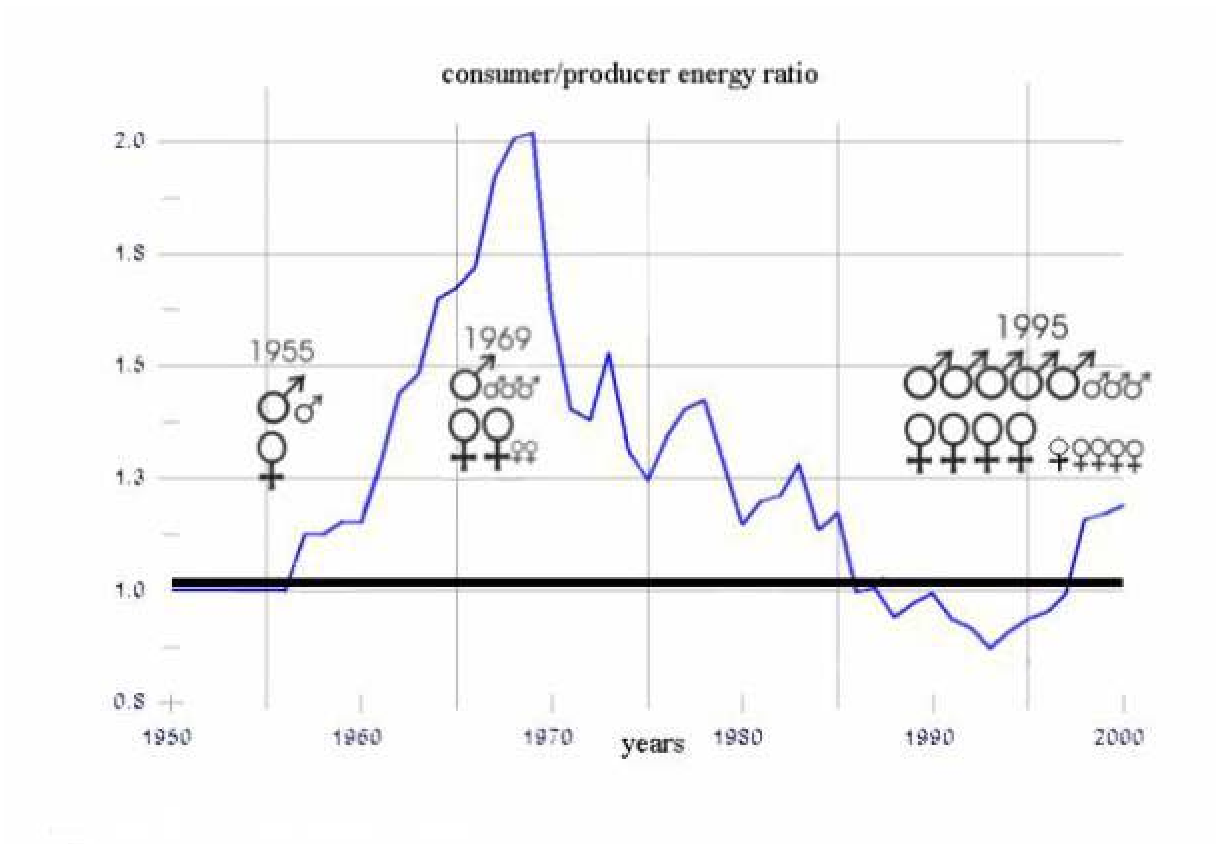
The ratio of labor availability to the burden of consumers within a household can be measured and provides an indicator of the level of stress that households endure and must manage. This stress, referred to in this study as energy stress, is the burden that falls on producers who must provide for additional consumers. An unmodified 1:1 consumer to producer ratio implies that for every consumer in the household there is one producer. A household with a 1:1 consumer to producer ratio can be considered to be experiencing relatively low energy stress, because for each person consuming from the household stores, there is one person producing or contributing. However, an unmodified consumer to producer ratio, such as introduced by A.V. Chayanov, calculated using an either/or to indicate status as a consumer or producer, does not sufficiently illustrate fluctuating energy requirements or availability based upon gender, age and physical activity levels found within the household. Therefore, a modified consumer to producer ratio was calculated here, based upon aggregated annual household energy requirements, to graphically demonstrate fluctuating household stress levels.

The modified consumer-producer ratio represents energy requirements of the consumers divided by the energy requirements of the producers. It is based upon the World Health Organization recommended daily caloric intake, and incorporates the nutritional differences in sex, reproductive status, age, and physical activity levels in adults and children. [16] Therefore the modified ratio reflects the differences in nutritional requirements found between adults and children, men and women, pregnant and lactating women, and various levels of physical activity.

Graphing longitudinal energy stress—spanning the life of a household—illustrates increases and decreases in stress endured by a household due to changing composition. Figure 1 represents the severity of energy stress experienced by a Senegalese household since its inception nearly fifty years ago when the male head of household left his village of birth and took his first wife. Three points in time (1955, 1969 and 1995) are of particular interest, indicating how household composition affects livelihood strategies in subsistence farming households.

It is natural to assume that a household will experience the highest degree of energy stress when it must provide for the largest number of members; this however is not always the case. With energy stress based solely upon the number of household members, the household depicted in Figure 1 would have encountered the most energy stress during 1995 when it contained 17 members. However, at this time, this household had a relatively favorable consumer to producer ratio (15:12) even though the household contained the greatest number of members since its inception. Among the household members in 1995 were: the male head of household, his three wives, three adult sons, an adult nephew and his wife, and various children. Therefore, household composition, disaggregated to reflect gender and age, is more important than the sheer number of members a household contains at any given time. In addition to the number of consumers and producers in the household, intra-household diversity in the form of age, sex and physical activity level becomes a crucial factor when determining where energy stress falls.

Figure 1: Household Energy Stress Curve



In Figure 1 the horizontal line shows a 1:1 consumer to producer ratio, for every consumer in the household there is one producer. For example, an adult couple—with no children—who are both engaged in production activities while consuming from the household exhibit very little energy stress. This scenario is illustrated in Figure1 by the horizontal line. The energy, in kilocalories, required by the consumers is roughly equal that required by producers. Divergence from the horizontal line reflects a change in household composition: numbers, ages, reproductive status, or physical activity level of members and therefore an alteration in the level of energy stress.

Any upward deviation implies an increase in household energy stress, while any downward trend denotes a decrease in energy stress. In other words, when household composition results in a peak above the line, the household is exhibiting an unequal consumer to producer ratio in which the energy required by the consumers is greater than that required by the producers. In addition to sustaining him or herself, each producer is also responsible for supporting additional household members (consumers), who are most likely children, elderly, or adults who are completely dependent upon others and unable to contribute to household production. This shifting balance between consumers and producers is key to understanding smallholder systems that are characterized as relying on their own labor. [17]

When household composition results in a dip below the horizontal line, the household is in a situation where the energy of the producers is greater than that of the consumers. Household members engaged in off-farm employment far from the village frequently cause this situation. These individuals do not figure into the consumer calculation for the household because they are physically absent, thereby consuming few if any resources. They do figure into the producer calculation because their energy is used to contribute remittances to the unit.

In 1955, the household in Figure 1 was "new" or just formed. It was under relatively low total energy stress with three consumers to two producers. However, this is misleading given the gender division of labor within the household. The woman's responsibility for domestic tasks left her with limited time to devote to rice production. Therefore the majority of production activities fell to the other producer in the household, the man.

In 1969 this household experienced its highest level of energy stress to date because of an unfavorable consumer producer ratio, 8:3 with eight consumers, including five children and only three producers. However, in this instance, the household had two adult women who could manage their labor to accomplish both domestic and production activities.

In 1995, the study household could be considered mature with a large population. Based solely on bodies present, one could assume that high energy stress prevails. Not so. At this time there were seventeen household members, fifteen of whom were consumers, relying on twelve producers. Due to birth order in the early years of this household, the head of household opted to send sons to seek off-farm employment thereby lowering consumption requirements and sending remittances.

As shown by Figure 1, stress due to changes in household composition is cyclical. Point-in-time examination of resource availability within a household, without regard to current or past stress levels, may only tell half of the story. Modified consumer to producer ratios illustrate the need for attention to constantly changing stress levels, but do not show how differentiated or disaggregated stress affects women and men differently. Longitudinal examination of energy stress can mask how changing composition affects different individuals. Thus it is necessary to conduct gender-specific examination of these units over time to determine who, if anyone, bears the brunt of a particular situation.

DISAGGREGATED HOUSEHOLD STRESS: LINEAR PROGRAMMING

Linear programming is a method of maximizing the outcome of one or more objectives relative to the constraints placed upon those objectives. These outcomes depend upon the household's objectives. For example, consider a household seeking to maximize its cash generation while meeting some minimum food requirement. The linear program (LP) model considers how much labor, land, cash and other resources the household has available. It then considers the amounts and combinations of those resources the household must use to meet defined subsistence requirements. Finally, using resources remaining after satisfying these minimum household needs, the model maximizes (or minimizes) another household goal or objective such as food stores, discretionary cash, or leisure time. To create LP models, data concerning specific activities are collected in rates including time, labor or cash needed to perform a particular activity per area of land, person or household and corresponding outputs. LP models, validated to reflect real conditions, can indicate where energy stress may affect livelihood systems, activities and strategies; and with gender disaggregated data, can show gender-specific labor shortages or surpluses. LP models can also uncover seasonality of energy stress and its differential impacts on men and women.

An LP model was created to simulate the livelihood system of the Fulbe study household in Figure 1 at three different points in time, 1955, 1969 and 1995. Results are presented in Table 1. Total available female labor in 1955 is taken up by household activities such as childcare, food gathering, preparation, serving and clean up, water collection, laundry, and fuel wood collection. Clearly, the one adult woman in this household at this time has no labor to devote to rice production. The burden of production falls to the man and his labor alone meets household consumption (energy) requirements. He uses the cropping mix depicted in Table 1. With this household composition he cannot afford start up costs for groundnut production and would have to borrow money or seed. This is a likely strategy but when provided with additional cash for increased groundnut production his labor is constrained at current levels. This household has very few resources available and energy stress on both the male and the female severely limit their options. Groundnut production with available labor generates the household's annual income, equivalent to $175.

Table 1: LP: Production and resource allocation for study household

Output	1955	1969	1995
Off-Farm Workers, Number of Men	0	0	2
Groundnuts, Area Cultivated in Hectares	1.1	.49	6.7
Cereal Grains, Area Cultivated in Hectares	.88	1.5	1.2
Rice, Area Cultivated in Hectares	0	0.6	2.7

Unused Male Labor, Days Per Year	0	0	0
Unused Female Labor, Days Per Year	0	0	102
Year End Cash in CFA* 500 CFA=1$ US	87,791 ($175 US)	36,089 ($72 US)	652,387 ($1,304 US)

*Central West African Francs

The study household experiences its highest energy stress in 1969 (see Figure 1) when there were two women and one man to produce for themselves and their five children. A linear program simulating this household composition shows that the household could expect to earn less year-end cash in 1969 than they did in 1955. Increased female labor availability for rice production has reduced the proportion of total cereal grains that the male must produce, but due to greater overall cereal requirements, the male devotes more of his available labor to this endeavor. Male labor is no longer producing the entire cereal grain requirement, yet year-end cash has decreased because he has less time to devote to groundnut production, his only cash generating activity. In 1969 this household generated the equivalent of $72.

Figure 1 shows that in 1995 this household experienced low energy stress, falling below the horizontal (1:1) line for the first time since its inception. There are now seventeen household 'members', fifteen of whom are consumers, relying on twelve producers. Based upon 1995 household composition, the LP predicts (see Table 1) that due to ample male labor, two men can seek off-farm work and send remittances. The benefit of this strategy is two-fold: the household need not meet their consumption requirements and they remit cash. The remaining male labor in the household produces the minimum cereal grain required of them (to achieve a culturally acceptable diet) and devotes the rest of their labor toward groundnut production to generate cash. Available female labor (four adults) is not a limiting factor in this household in 1995. In fact, at year-end, the LP model shows 102 days of unused female labor (see Table 1). As soon as all domestic and production requirements utilizing female labor are met, unused labor begins to accrue because this model offers no alternative female activities, cash generating or not. The excess female labor would likely be devoted to additional rice production. Although there are many mouths to feed in 1995, there are a significant number of hands to do the work and the household generates the equivalent of $1,178.

Managing stress due to household composition has many peripheral effects on a household. Consider for example the diet of a household with abundant male labor and scarce female labor. They rely mainly on the crops, maize, millet and groundnuts produced by men and have limited access to rice, vegetables or other crops produced by female labor. On the other hand, a household with abundant female labor would produce greater quantities of rice, freeing up male labor for income generating activities, and possibly leading to increased food security. Households typically gear their cereal cultivation toward a 'culturally acceptable' diet whereby two out of three daily meals are based upon millet or rice. A steady diet of either rice or millet is not considered culturally acceptable and is usually indicative of stress or the inability of a household to me its needs. Therefore, household objectives in this system include attaining a culturally acceptable diet for as much of the year as possible.

Periodic stresses such as drought, unfavorable market conditions, or death of key individuals within the household call for strategies that get the household through the indeterminate stress period. Such strategies include: selling cattle, arranging marriages of daughters, sending men to work off-farm or adaptation of production activities to existing conditions. Cyclical stresses caused by illness, pregnancy or prolonged absence from the village of a key producer is also managed. In such cases, augmenting or replacing labor from nearby, existing pools is used to reduce stress until it has passed. Any acceptable strategy or combination thereof would, by definition, be appropriate to the culture.

Realignment of households in family groups is a typical strategy of household heads to mitigate stress, especially in times of scarce labor. In addition to manipulating inter-household relationships, heads of household manipulate conditions within their own households to alleviate stress. Men in these households manage the labor bottleneck at soil preparation and seeding time by sharing resources. Women typically manage it by finding another female, usually a young relative from another village, to help with their household chores thereby freeing up their own labor for production activities.

WOMEN AND SOIL FERTILITY

Given the complexity of the livelihood system and the unpredictable nature of household composition and stress, targeting women farmers is very much like trying to hit a moving target. The task becomes even more difficult when working with resource-limited farmers with little or no access to cash. Nonetheless, development professionals must commit to understanding livelihood systems within which women work, as well as their goals and motivation, in order to create technologies and recommendations that address real needs.

Addressing the issue of soil fertility for women's crops and fields in the study village, the following questions were posed, given that Fulbe women do not currently use any chemical fertilizer but have cultural motivation to maximize production, 1) what do they do to increase soil fertility? 2) If a project were started to introduce fertilizer on credit for village women, would they participate?

This research and analysis was meant to assess the likelihood of women’s improving soil fertility by use of any method, including organic or chemical. A rapid assessment of the area showed that women’s primary, and sometimes only, production activity is rice cultivation. The likelihood of women increasing their rice yields by incorporating chemical fertilizers, received on credit, into their production practices was examined.

Fulbe women have little or no access to cash with which to purchase or repay loans for fertilizer. Given their culturally sanctioned priority of increasing rice production, they would likely be interested in increasing their yields. With few other production activities available to them, Fulbe women would incorporate fertilizer into rice cultivation *only if it were affordable.*

Use of chemical fertilizers by any farmer in this area is uncommon due to limited availability and/or high cost. Regular chemical fertilizer use by women, on rice, is extremely rare and dependable or affordable supplies are only two of many barriers to adoption. Women save seed from year-to-year and according to cultural norms, do not sell rice. Thus, a cultural change introducing cash inputs into rice production is highly unlikely. Of equal importance is that women do not produce rice as a cash crop, nor do they invest money in rice cultivation. One practical obstacle is the probability that male household members would appropriate fertilizer acquired by women and use it on their cash crops. As previously stated, Fulbe men are ultimately responsible for household food security and could therefore compel women to 'give up' their fertilizer for use on cash crops. Finally, chemical fertilizer is available only at high transport costs in the area.

How then could a soil fertility improvement project help these women? Based upon production and household data, LP models were created to simulate production systems. Once the model was validated to reflect existing conditions, "what if?" questions relative to the hypothetical project were posed and the model run again to generate another solution. Among the obvious questions to be asked were (a) would women use chemical fertilizer on their rice if it were available? (b) how could they access it most effectively; via a grant (free fertilizer) or credit? (c) which households could take advantage of such a project and increase their yields, profits or food production? and (d) which households would benefit most from fertilizer use?

In response to the first question, of course women would use fertilizer to increase production if they could afford it and if it fit within their existing production schemes. Were fertilizer given as a grant, assuming the men did not appropriate it from them, women would incorporate it into their agricultural practices. Were women given fertilizer and able to convince men that the resulting increase in rice production would lessen their burden of millet and maize production, the women might be able to keep a portion and apply it to their fields. Fulbe women have limited access to cash however, so any purchase of fertilizer with cash up front is likely out of the question. As cash is not invested in non-cash generating crops, and these women do not sell their rice, it would prove difficult for them to pay back a loan in cash.

In response to the second question (how could women access chemical fertilizer?), potential solutions are 1) giving them a grant; and 2) allowing women to fertilize rice on "credit", paying back a certain quantity of their harvest—in lieu of cash—in return for the fertilizer they receive. Both of these solutions were explored using LPs. Different costs in fertilized rice, or different 'interest rates', calculated as different percentages of yield to be returned to repay the credit, were calculated to determine if and when various households could and would participate in such a project.

In addition to expected increased yields of fertilized rice, increased labor is also associated with fertilized rice production as compared to traditional rice production. Soil preparation and seeding time would be comparable for fertilized and non-fertilized rice. However, fertilizer use would increase weed growth and thus women's weeding time. Due to higher yields, harvest time would also be increased.

After the procurement of chemical fertilizer, participation in this project depends upon female labor availability. Thus the keys to adoption of fertilized rice in these scenarios are the price of fertilizer and access to female labor as determined by household composition. As such, three scenarios have been created to represent various "costs in rice" for households of various compositions.

The first scenario (Table 2) depicts the 1955 household of Figure 1 comprised of *one woman, one man and one child*. In this model, all available female labor is consumed by domestic activities, leaving none for any sort of rice production regardless of cost. A grant or free fertilizer would not increase women's rice production in this household unless more female labor was available. In this household all consumption requirements are met by male cereal grain production and all available female labor is dedicated to household tasks with none available for rice production of any sort.

Table 2: Scenario one: Adoption of fertilized rice

Number of Women in Household	Available Female Labor	Labor Consumed by household	"Cost in Rice" of credit	Traditional Rice Grown	Fertilized Rice Grown	Unused Female Labor
1	330 days	330 days	0 kg/ha	0 ha	0 ha	0 days

In summary, due to household composition—and the resulting scarcity of female labor—there is no rice grown in this scenario and all female labor is consumed by domestic tasks. Thus, this household would be unable to benefit from this project and should not be targeted at this point in time.

The second scenario (Table 3) depicts the 1969 household of Figure 1 comprised of *two women, one man and five children*. In this case, there is available female labor in excess of household domestic requirements. If there were no cost for fertilizer—if it were free—and women kept the total they produced, this household would cultivate 0.5 hectares of fertilized rice. They would still opt to produce 0.5 hectares of fertilized rice if they had to return 200 kg/ha, or one-sixth of the expected yield. However, at a 400 kg/ha cost in rice, women in this household would revert to their traditional practices, and cultivate 0.6 hectares to meet household consumption needs without using fertilizer.

Table 3: Scenario two: Adoption of fertilized rice

Number of Women in Household	Available Female Labor	Labor Consumed by household	"Cost in Rice" of credit	Traditional Rice Grown	Fertilized Rice Grown	Unused Female Labor
2	660 days	570 days	0 kg/ha	0 ha	0.5 ha	0 days
			200 kg/ha	0 ha	0.5 ha	
			400 kg/ha	.6 ha	0 ha	

This implies that producing traditional rice is a more efficient use of labor at times when female labor is scarce and fertilizer 'costs' are high. The household invests female labor in fertilized rice cultivation (depending on the "cost in rice" of fertilizer) until yields drop below yields of traditional rice. If returns to labor investment in fertilized rice are sufficient, this household could participate in and benefit from this project. In summary, women cultivate at least 0.5 hectares of rice and all female labor would be used regardless of adoption of the new technology.

The third scenario (Table 4) depicts the 1995 household in Figure 1 comprised of *four women, five men and eight children*. In this case, there is available female labor in excess of household domestic requirements. If grants of fertilizer were made to the women in the household, and women kept the total they produced, this household would cultivate 1.8 hectares of fertilized rice. At a cost of 200 kg/ha, they would produce 2.2 hectares of fertilized rice. At a cost of 400 kg/ha, or one third of expected yields, this household would still grow fertilized rice amounting to 2.7 hectares. It is not until the cost in rice for fertilizer reaches near 600 kg/ha, or half of expected yields, that this household would revert to producing traditional rice to meet their consumption demands.

Table 4: Scenario three: Adoption of fertilized rice

Number of Women in Household	Available Female Labor	Labor Consumed by household	"Cost in Rice" of credit	Traditional Rice Grown	Fertilized Rice Grown	Unused Female Labor
4	1320 days	810 days	0 kg/ha	0 ha	1.8 ha	183 days
			200 kg/ha	0 ha	2.2 ha	118 days
			400 kg/ha	0 ha	2.7 ha	20 days
			600 kg/ha	2.7 ha	0 ha	102 days

With relatively abundant female labor, the women in this household are able to take advantage of a credit project and could pay back a considerable sum in return for fertilizer. According to the LP, regardless of the type of rice produced, these women grow between 1.8 and 2.7 hectares of rice, without ever consuming total female labor.

The three scenarios set out here indicate that as available female labor in the household increases, households are more likely to choose fertilized rice and can afford to "pay back" more rice. Thus, household composition is a determinant of whether or not participation in a soil amelioration project for women is possible and to what degree. Only the household in the third scenario is really able to take advantage of a project offering fertilizer on credit for increased rice production. This option would be crucial in the study village as there are few if any cash generating activities for women, nor cultural incentives to lure them away from rice cultivation.

The hypothetical project presented here only addresses soil amelioration for women's rice production because of the limited livelihood options available to them. However, as biophysical and socioeconomic conditions in the area change, women may need, opt, or be encouraged to alter their production activities in search of income generating opportunities. In this event, policy makers and development professionals must plan with the knowledge that not all women farmers are the same. The scenarios presented here clearly indicate *which* women would have the resources to participate in the project, and to what degree. Similar assessments and analysis should be done for any development effort, regardless of whether or not it is designed specifically for women.

IMPLICATIONS

In the previous scenarios linear programming models were used to show how changes in household composition impact women and dictate their availability for certain roles within the household. In order to understand resource allocation decisions in the household, development professionals must acknowledge differential decision-making with regard to gender. In the Casamance, Fulbe women make their respective production and resource allocation decisions based upon their own criteria, and their knowledge of a whole set of complex issues affecting their household's survival.

Development professionals must have a clear understanding of their target audience, including *all* decision makers, if they are to understand farmers' constraints to adoption and causes of food insecurity at the household level. Thus technologies and recommendations must be tailored to specific types of households and decision makers—including women—matching their available resources and fitting within their existing schemes. By disaggregating household stress by sex and age, linear programming models can help development planners formulate policy interventions that help women better manage the complexity of issues they face.

The diversity of livelihood strategies found across time, within the households in this study illuminates the fact that not all women engaged in agricultural production can afford to follow the same path toward survival. Rather, the types and quantities of resources women have at their disposal, to meet household demands, determine which path is followed. By misunderstanding this complex set of conditions, researchers and change agents might aim a brilliant solution at the wrong audience or address the wrong problem altogether.

Notes

1. FAO 2002, www.fao.org/Gender/en/agrib4-e.htm.
2. Chambers 1997.
3. Jochim 1981, and Goody 1989.
4. The author developed this reasoning while comparing the study Fulbe village with a neighboring Mandinka village. The two villages, side by side across the river, shared

agro-ecological and bio-physical conditions yet their livelihood systems were different; for brevity we do not discuss the Mandinka village livelihood system in this paper (see Sullivan 2000). Within the livelihood system of the Fulbe village, economic factors (household composition) determine household decision making strategies. We are looking at different levels or scales of analysis, and so there is not a contradiction between culture impacting livelihood systems and economic factors and household composition impacting livelihood strategies chosen within that system.

5. In this case, livelihood systems are defined as the range of activities to which a household has access in the effort to meet their needs. Livelihood strategies are the specific resource allocation decisions made by each household over time, within the existing, possibly evolving, livelihood system.
6. Quisumbing 1996.
7. Quisumbing 1996
8. Safa 1995.
9. Deere, et al. 1990.
10. Deere, et al. 1990.
11. The existence of female-headed households in this area is extremely rare and there were none in the study community. In the case of divorce, a wife typically returns to her village of birth while the husband remains in his. If a woman's husband dies her options are: 1) become a wife of her husband's brother or other male relative; 2) return to her village of birth; or 3) become part of an adult child's (usually a son) household.
12. Chambers 1997, Koenig, Diarra and Sow 1998, and Netting 1983.
13. Norman 1983, and Shaner, Phillip and Schmehl 1982, and Thorner 1986 and Goody 1989.
14. Buvinic 1990, and Hamilton 1995.
15. Stark 1979, and Hamilton 1992, and Hamilton 1995.
16. FAO/WHO/UNU 1985.
17. Chayanov 1966.

References

Buvinic, M. "Women and Agricultural Development," in C. K. Eicher and J. M. Staatz eds. Agricultural Development in the Third World. Baltimore, MD: Johns Hopkins University Press, 1990.

Chambers, R. Whose Reality Counts? Putting the First Last. London: Intermediate Technology Publications, 1997.

Chayanov, A.V. The Theory of Peasant Economy. Homewood, IL: The American Economic Association, 1966.

Deere, C. D., Antrobus, P., Bolles, L., Melendez, E., Phillips, P., Rivera, M., and H. Safa. In the Shadows of the Sun: Caribbean Development Alternatives and U.S. Policy. Boulder: Westview Press, 1990.

Food and Agriculture Organization/World Health Organization/United Nations University. "Energy and Protein Requirements." Report of Joint FAO/WHO/UNU Expert Consultation. World Health Organization Technical Report. Series # 724. Geneva; II, 1985.

Goody, J. "Futures of the Family in Rural Africa." Population and Development Review, Issue Supplement: Rural Development and Population: Institutions and Policy, 15 (1989): 119-144.

Hamilton, S. "Visible Partners: Women's Labor and Management of Agricultural Capital on Small Farms in the Highlands of Central Ecuador." Urban Anthropology, 21 (1992):353-383.

Hamilton, S. "The Two-Headed Household: Gender and Rural Development in the Ecuadorian Andes." Unpublished Doctoral Dissertation: University of Kentucky, 1995.

Jochim, M.A. Strategies for Survival: Cultural Behavior in an Ecological Context. New York: Academic Press, Inc., 1981.

Koenig, D., T. Diarra, and M. Sow. Innovation and Individuality in African Development: Changing Production Strategies in Rural Mali. Ann Arbor, MI: The University of Michigan Press, 1998.

Netting, R. McC. Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture. Stanford, CA: Stanford University Press, 1993.

Norman, D. W. "The Farming Systems Approach to Research," in C. Butler-Flora ed. Proceedings of Kansas State University's 1982 Farming Systems Research Symposium: Paper No. 5. Farming Systems in the Field. Manhattan, Kansas: Kansas State University. (1983):7-19.

Quisumbing, A. "Male-Female Differences in Agricultural Productivity: Methodological Issues and Empirical Evidence." World Development, 24 (1996):1579-1595.

Safa, H. The Myth of the Male Breadwinner: Women and Industrialization in the Caribbean. Boulder, CO: Westview Press, 1995.

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

Stark, L. "Division of Labor and the Control of Economic Resources Among Indian Women in the Ecuadorian Highlands." Andean Perspectives 3 (1979):1-5.

Sullivan, A. "Decoding Diversity: Strategies to Mitigate Household Stress." Unpublished Master's Thesis: University of Florida, 2000.

Thorner, D. “Chayanov's Concept of Peasant Economy”, in D. Thorner, B. Kerblay and R. Smith, eds. The Theory of Peasant Economy. Madison, WI: University of Wisconsin Press. (1986):xi-xxiii.

Reference Style: The following is the suggested format for referencing this article: Sullivan, Amy. "Gender, Household Composition, and Adoption of Soil Fertility Technologies: A Study of Women Rice Farmers in Southern Senegal." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a6.htm

The Effect of Cash Cropping, Credit, and Household Composition on Household Food Security in Southern Malawi

ANDREA S. ANDERSON

Abstract: Diversifying household activiies is essential to household food security in Southern Malawi. Farms are extremely small; many farms are less than half a hectare. With these small landholdings, food security cannot be achieved by subsistence farming alone. Cash crops and off-farm income are key to these livelihood systems. This paper presents the findings of research conducted in 1998 as a part of a study to examine options for improving household food security in Southern Malawi. The researcher used linear programming to model household farming systems. These models were used to test different options for improving food security. The following options were tested: a maize safety net, a fertilizer safety net, introducing credit for tobacco, increasing off-farm work opportunities, and introducing a loan to start a small business. This study also considered differences between female-headed households (FHHs) and male-headed households (MHHs) to discover if there were differences between the two household types, and if so, to find out how the differences affect the households' situations.

Introduction

Malawi is a small country in Eastern Africa bordered by Tanzania, Mozambique, and Zambia. In 1999, Malawi's population was approximately 10 million, 87% of which lived in rural areas.[1] Agriculture is extremely important to the country, as it provides employment for nearly 90% of all households, accounts for 40% of the GDP, and generates 77% of the revenue from Malawi's exports.[2] Smallholder farmers are important, as almost 70% of the agricultural produce comes from smallholder farmers. In Malawi, as in other African nations, women do a good deal of the farming.[3]

The dry season in Malawi lasts from May until October, and the rainy season lasts from November to April.[4] Most agricultural work occurs during the rainy season, and crops are harvested at the end of this season in April, May, and June. In the dry season, the land is prepared by burning the crop residue and turning it under, and by making ridges for maize planting.

The typical farming system in this study area is a maize-based system, with other food crops, such as cassava, pigeon peas, beans, groundnuts, and pumpkins, intercropped with the maize. The majority of these food crops are eaten, while some households sell small amounts in the market. Some households grow cash crops for sale, such as tobacco or rice. Most households participate in some form of off-farm work. In male-headed households, the man is usually the family member to participate in off-farm work, while in female-headed households, the female head of the household participates in off-farm work alone, along with other household

http://www.africa.ufl.edu/asq/v6/v6i1-2a7.pdf

ISSN: 2152-2448

members, or another household member would participate in the off-farm work alone. This off-farm work is extremely important, as it is often the main source of income for the household. Malawi is the sixth poorest country in the world, and many Malawian households are food-insecure.[5] Nutritional deficiency is the number one cause of death for children under the age of five.[6] Malnutrition is a factor among adults as well, adding to the problems of disease, hard labor, and early and frequent pregnancies among women, which all contribute to the poor health of many rural adults.[7]

CONSTRAINTS TO FOOD SECURITY

Household food security has been defined as "sufficient food consumption by all people at all times for a healthy and productive life."[8] Achieving food security in Southern Malawi will require implementing strategies that improve the overall household livelihood system. It will require more than simply improving crop yields. Landholdings in this area of Malawi are very small, and most smallholder farmers are not able to grow enough food to sustain their household, even under ideal situations. Forty-one percent of the rural population is farming less than 0.5 hectares.[9] This is only enough land to produce three to four months of food, and the rest is purchased, often by *ganyu* work, informal farm labor that is paid either with cash, maize, or other food.[10]

Off-farm income is extremely important to the household livelihood systems of this area of Southern Malawi. However, many households in the area lack access to higher-paying types of off-farm work, such as employment in the formal sector (an official job, paid with a salary or wages). Informal sector work, any "unofficial" job, included activities such as working as a vendor in the market or participating in *ganyu* labor.

Many households participate in the lower-paying informal sector by running small businesses or doing g*anyu* labor. *Ganyu* labor, although available to most households, is generally very low paying and is usually only available in the agricultural months when farmers are busy with their own fields. Many households are unable to earn enough money to purchase sufficient maize in months after their own maize stocks are gone.

Household composition largely determines the way in which a household is able to respond to changes. Household composition is defined as the number of individuals in a household and their ages and genders.[11] It affects the amount of available farm labor, determines the food and nutritional requirements of the household, and often affects household food security. In this paper, only differences between MHHs and FHHs were considered.

Female-headed households (FHHs) have additional constraints to achieving food security. They tend to have smaller farms, lower agricultural yields, less access to inputs, and less available labor. Women's farms (cultivated by FHHs or married women) are much smaller than men's farms, and FHHs constitute 40% of the smallholders with less than 0.5 hectares of land.[12]

FHHs also generally earn less money than MHHs. FHHs often participate in the informal sector, selling small amounts of crops, making and selling goods, or in *ganyu* labor; however, the informal sector usually generates less revenue than the formal sector.[13] FHHs also have the added constraint of having one fewer laborer for the family, since there is usually no adult male in the household. Without an adult male, the household often lacks access to better land, fertilizer, and higher-paying off-farm work.[14] Because of this, FHHs are often in the lowest income bracket.[15] In Malawi, they make up 42% of the poorest households, even though they are only 30% of all rural smallholder households.[16]

DATA COLLECTION

In June and July of 1998, in-depth surveys were administered to 20 smallholder farming households, 8 FHHs and 12 MHHs, in three villages in the area around the town of Malosa in the Zomba district of Southern Malawi. The results of this study were used to construct linear programming models (LPs) of livelihood systems in order to test options that could improve household food security in the study area. The construction and use of the LP models is discussed later.

All households interviewed were in one of three area villages. The villages were Nkalo, Mpama, and Jauma. These villages were chosen because of their proximity to each other and because of the similarities in their livelihood systems and farming conditions. Within these villages, households were randomly surveyed regarding household composition. Households with at least two household members were asked if they were willing to participate in the study. Among these households were FHHs and MHHs, families with only small children and families with older children who helped on the farm, and those with and without access to credit. None of the households interviewed from these villages grew tobacco, so in addition to these families, two households (from other villages) growing tobacco were interviewed.

The survey was administered to households in the form of a personal interview. This allowed for open-ended discussion if an answer was unclear. A predetermined set of questions gave direction to the interviews and ensured that the researcher obtained all the information that she set out to obtain. It also standardized the information received from each household to ensure that all households answered the same questions. However, the interviews were also informal, and allowed for discussion of other issues not mentioned on the survey.

The survey was divided into three parts. The first part of the survey primarily dealt with land and labor issues. Questions assessed the household's land use, crop yields, and farm inputs (such as fertilizer). Other questions dealt with on-farm labor requirements for each crop grown and off-farm labor. This part of the survey also asked labor-related questions about the household, such as, "who does household chores?"

Crop yields were determined by asking the farmers how much of each crop they were able to harvest in the previous year, and if these were typical yields. Fields were measured to determine their size. For fields that were too far for the researcher to visit, the farmer would provide an estimated size of his or her farm.

The second part of the survey gathered information about household cash flow. Questions dealt with farm cash inputs and outputs, household income, and household expenses. Other questions dealt with credit, including as access to credit and repayment of credit. Finally, questions concerning household decision-making were asked, such as "who is responsible for decisions regarding family/money/crops grown?"

The third part of the survey was based on a questionnaire developed by Robert Uttaro.[17] Selections used from this instrument included several questions about possible constraints to fertilizer use and possible constraints to using credit. Farmers were asked about their knowledge of the different techniques and their willingness to implement them. These questions allowed the interviewer to discover what, if any, constraints farmers faced in implementing each change.

Each section of the survey was administered in a separate session, which required each household to be visited and interviewed three times. Each session took between thirty minutes and one hour. Often the researcher was only able to interview the woman in the household, because the man was unavailable. However, if the man and woman were both available, the interview was conducted with both present.

RESULTS OF RESEARCH

Smallholders surveyed all had very small landholdings. As shown in Table 1, half the smallholders studied were farming 0.5 hectares or less. However, the FHHs tended to have less land than the MHHs. Of the FHHs, six out of eight households had 0.5 hectares or less, while only four of 12 MHHs had landholdings that small.

Table 1: Farm sizes of households studied

	0.5 ha	0.6 - 1.0 ha	1.1 - 1.5 ha	1.6 - 2.0 ha	2.1 ha	Total
FHH	6	1	1	-	-	8
MHH	4	7	-	-	1	12
Total	10	8	1	-	1	20

Many farmers interviewed were unable to use very much fertilizer to improve their yields. FHHs seemed to be in a worse situation than the MHHs, since half of the FHHs surveyed were not using any fertilizer, whereas only three of the 12 MHHs were using no fertilizer. As a result of the farmers' extremely small landholdings, low yields, and a lack of fertilizer use, only three households studied were found to be self-sufficient in maize production (two MHHs and one FHH). The seventeen other households surveyed were forced to purchase maize during the year to supplement the maize they grew.

Table 2: Fertilizer Use

KgN/ha	0	<10.0	10.1-20.0	20.1-30.0	30.1-40.0	40.1-50.0	50.1-60.0	>60.0	Total
FHH	4	-	1	-	2	-	-	1	8
MHH	3	-	3	5	-	1	-	-	12

Total	7	-	4	5	2	1	-	1	20

Hybrid maize responded better to fertilizer and had higher yields than local maize. However, as shown in Table 3, because of the cost of the seeds, storage difficulties, and other problems, many smallholders surveyed did not grow hybrid maize. Most of the FHHs (six out of eight) were growing only local maize; the other two FHHs grew both local and hybrid. More MHHs were able to grow the higher-yielding hybrid maize, two MHHs growing only hybrid and seven growing both varieties. Only three of the 12 MHHs grew only local maize.

Table 3: Local vs. hybrid use

	Local Only	Both	Hybrid Only	Total
FHH	6	2	-	8
MHH	3	7	2	12
Total	9	9	2	20

Since 17 out of the 20 households studied were not self-sufficient in maize production, a lack of cash available for food purchase would be a hindrance to food security. All households either participated in some type of off-farm income activity, received remittances from a family member who lived elsewhere, or both.

As shown in Table 4, four FHHs and four MHHs participated in *ganyu* labor. Although *ganyu* labor was an important source of cash and food for these farmers, some commented that there was a shortage of available *ganyu* work. This shortage lessened the amount of work they were able to do and affected the amount of cash or food they were able to earn. FHHs who did *ganyu* work averaged only 3 months per year in *ganyu*. MHHs worked an average of 5.25 months per year in *ganyu*.

Small businesses, such as selling clothing or baked goods in the market, were run by four FHHs and four MHHs. However, two of these FHHs' businesses were selling firewood in the village and the market. Although this activity has been included in the "small business" category, selling firewood requires no credit and earns much less income per month than other businesses. One constraint to starting a small business was a lack of access to credit. MHHs with informal sector income sources made an average of K1175 per month. FHHs only made an average of K701 per month. This K474 difference is due to a number of issues for FHHs, including less hours worked off-farm, and lower-paying types of informal work.

Only one FHH and five MHHs studied held formal sector jobs. Formal sector jobs tended to be higher paying than *ganyu* labor or small businesses. Households where a family member had a formal sector job tended to be much more financially stable and food-secure. Households with formal sector employment made an average of K1900 per month, although there were wide variations between households.

Table 4: Off-farm income

	Ganyu [a]	Informal Sector Job/ Small Business	Formal Sector Job	Remittances	Total
FHH	4	4	1	2	8
MHH	4	4	5	1	12
Total	8	8	6	3	20
[a]) Some households had more than one income source.					

As mentioned previously, one of the difficulties in beginning a small business was a lack of credit availability. As shown in Table 5, only two of the households studied used credit. Both households were FHHs. More FHHs than MHHs knew how to obtain credit as well. Six households knew where to get credit, and fourteen households did not know where to get credit. Of households without credit, eight households did not want credit. Six of these eight households reported not wanting credit because they were afraid of not being able to repay the loan.

Table 5: Credit

	Credit Use		Credit Sources	
	Use Credit	Do Not Use	Know of Sources	Do Not Know
FHH (total = 8)	2	6	4	4
MHH (total = 12)	-	12	2	10
Total (total = 20)	2	18	6	14

As the previous tables show, the FHHs studied had overall less land, used fertilizer less, used hybrid maize less, and had less cash income than the MHHs studied. They did, however, have more access to credit.

LINEAR PROGRAMMING

From the data collected, a linear program was developed using *Microsoft Excel*. A linear program (LP) is a program created on a computer and used as a planning tool for deciding between a large number of choices. LPs have been used in Farming Systems Research and Extension to model farming households' livelihood systems in order to reflect an accurate picture of the system.

An LP works by changing the quantities of different inputs to maximize a single output variable, which is selected by the researcher. The LP maximizes that variable by changing other inputs, such as hectares of land used for each crop, kilograms of crops sold, kilograms of food purchased, kilograms of nitrogen per hectare of fertilizer applied, and hours spent on off-farm work. If there are minimums that must be achieved for the household to be maintained, the LP will make sure to meet those minimums. For activities with household labor requirements, the LP will require the household to meet the labor requirement in order to pursue that activity. In this way, all of the household's resources are considered in the LP.

For this research, year-end cash remaining was maximized. Minimum household requirements included cash requirements and food requirements. As an example of a household labor requirement, if growing one hectare of maize requires 100 hours of labor in April, a household must have 100 hours of available labor in April in order to grow a hectare of maize.

Once an LP model accurately reflects a household's farming system, it can be a framework for testing alternative activities-such as growing a cash crop-before testing them on-farm.[18] The simulation can help the researcher to discover whether or not households would have the resources to implement certain activities.

Each LPs is programmed for an individual household's constraints-not using averages, but using data from an individual household, such as the amount of available agricultural labor from the family members, labor requirements for the farm, and the availability of off-farm income to the family. Furthermore, the amount of food and cash required by the individual household must be met in the LP solution for the program to find a solution ("to solve"). Therefore, an individual LP will not generally model an entire country or region.

The LPs in this research are modeled after real households. Since they are household specific and required a lot of time to collect the data and create, it would have been difficult to create enough LPs to have a statistically significant sample. Despite its small size, this data set provides information regarding what options would be candidates for real-life testing in the Malosa area. This data may also be beneficial in other areas of Southern Malawi with similar farming systems, off-farm income situations, prices, and yields as the study area.

Data from all 20 households were originally entered into a preliminary LP to see if the LP would model the households correctly. Validation was accomplished by examining the results from the LPs and ensuring that results were consistent with the actual household livelihood systems. The researcher compared the LP solutions and what the household actually did to see if there were significant differences. The main areas examined were crops grown, amount of fertilizer used, and year-end cash remaining. Once validation was established, seven household LPs were studied in depth (4 FHHs and 3 MHHs) and used to test different alternatives. The goal of testing these new alternatives was to see which ones would be useful for increasing food security and cash for discretionary spending, and to discern which options would be possible for each household.

Household LP solutions initially were required to obtain the World Health Organization's (WHO's) recommended level of calories and protein (see Table 6) for each household member.[19] However, for some households, it was not possible for the model to secure the WHO nutritional requirements for each household member. (In LP terminology, these LPs "did not solve.") In these cases, the household was too cash-restricted to afford enough maize to be food-secure at these recommended levels. These households were chronically food-insecure-constantly short on food. In these cases, the calorie and protein levels were lowered to 75%, 50%, or 25% of the WHO requirements, until a feasible solution was reached (see Table 7). When these household models were used to test new technologies to improve food security, the full WHO nutritional requirements were re-introduced into the matrix (to see if the LP would "solve"). In this way, the simulation would reveal whether or not the technology raised the household into a food-secure status.

Table 6: Energy and protein requirements based on bodyweight

	Energy/day	Protein/day
Males	(kcal)[a]	(grams)
0-11months	679.8	11.9
1 to 3	1112.0	12.8
4 to 6	1454.4	16.7
7 to 9	1758.0	22.7
10 to 12	1984.4	28.6
13 to 14	2177.3	37.8
15 to 16	2435.7	46.8
17 to 18	2657.2	51.9
19 to 29	3324.8	44.3
30 to 59	3285.6	44.3
60+	2287.0	44.3

	Energy/day	Protein/day
Females	(kcal)	(g)
0-11months	628.3	11.0
1 to 3	1057.3	12.2
4 to 6	1408.5	16.9
7 to 9	1570.9	22.8
10 to 12	1805.1	30.0
13 to 14	1942.6	38.0
15 to 16	2055.1	44.1
17 to 18	2113.0	42.2
19 to 29	2315.3	39.6
30 to 59	2344.8	39.6
60+	1886.7	39.6
pregnant	1573.4	45.6
lactating	1788.4	54.9
[a]Energy/protein requirements are from WHO (1985).		

Table 7: Monthly calorie requirements of each household (HH)

% of HH calories met:	100%	75%	50%	25%
MHH1	244,567	183,417	122,278	61,139
MHH2	360,947	270,710	180,474	90,237
MHHA	246,197	184,648	123,099	61,549
FHH1	74,045	55,534	37,022	18,511
FHH2	209,264	156,948	104,632	52,316
FHH3	322,007	241,505	161,003	80,502
FHHA	513,110	384,833	256,555	128,278

Each LP had numerous activities from which to choose. Agricultural activities included growing the following: 1) local maize intercropped with cassava and pulses with either no fertilizer, 10 kg N/hectare, 20 kg N/hectare, or 40 kg N/hectare and 2) hybrid maize intercropped with cassava and pulses with either no fertilizer, 10 kg N/hectare, 20 kg N/hectare, or 40 kg N/hectare. Agricultural activities that required special (wetter) land were the following: 1) *dimba* (wetland) vegetables, 2) sugarcane, 3) rice, and 4) bananas. Non-agricultural activities included 1) buying fertilizer, 2) off-farm employment (both male and female), 3) hiring labor, 4) purchasing maize, and 5) purchasing other foods, such as groundnuts, beans, pigeon peas, and cassava.

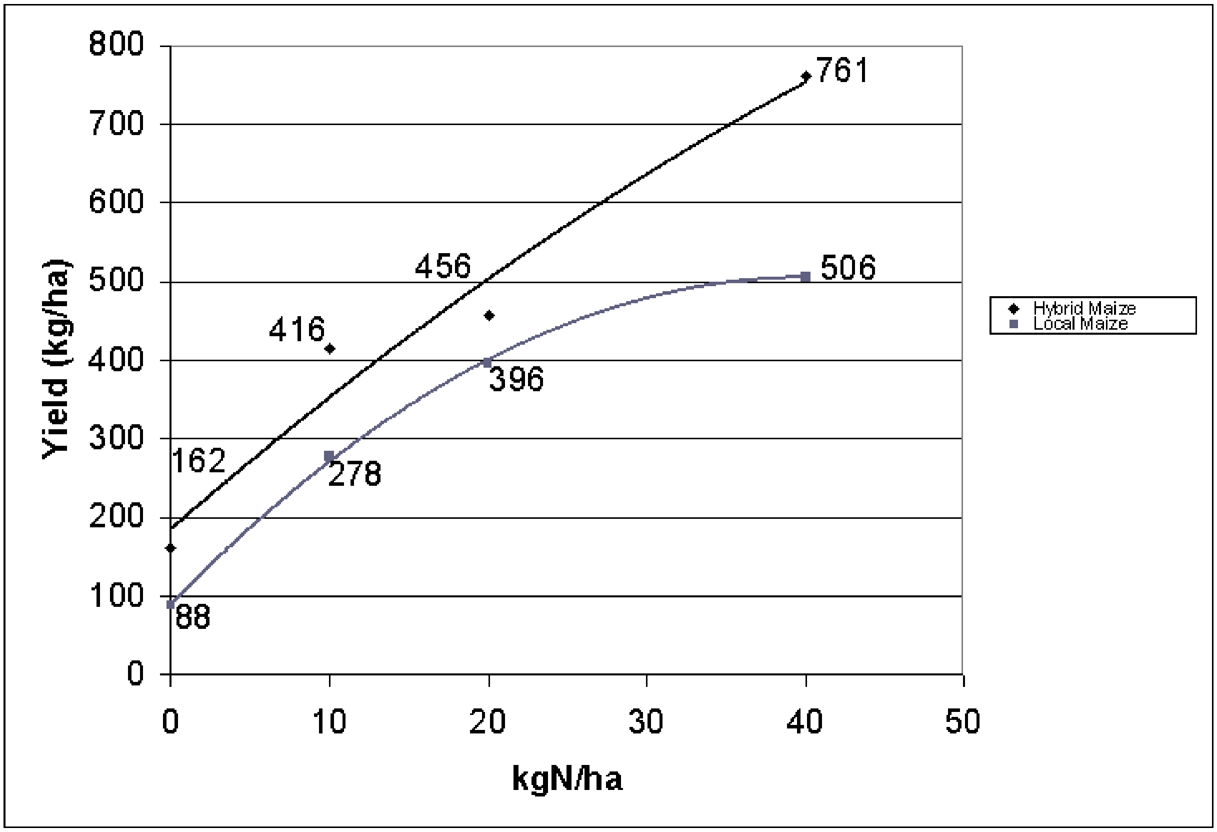
Household labor available for agricultural work was entered into the program as the maximum amount of household labor available. Cash needed for household expenses was entered as the minimum amount of cash needed for the family. This cash minimum had to be met in order for the household to run normally and for the linear program to give a feasible solution. If household cash or nutrition requirements were not met, the program would not solve. This meant that the household would not be able to function under these circumstances. The household would not be able to meet its basic food and cash needs.

Labor and cash needed for each crop grown were entered as requirements that the household must have in order to grow that crop. If the household did not meet the minimum cash and/or labor requirements, then the program would not be able to select that crop. Yields from each crop were entered as outputs from growing the crop. The amount of land available to the household was entered as the maximum amount of land available for agricultural work.

Yields were extremely low among smallholders interviewed (see Figure 1). Even with fertilizer, these maize yields were amazingly low. Other research from Malawi has recorded much higher yields; however, farmers surveyed in this research all reported extremely low yields. This area may have poorer than average soils or other conditions that cause low yields.

One farmer of special note used a fertilizer application rate of 60kg N/hectare. Her farm yielded 1365 kg/hectare of hybrid maize. She, however, was an atypical farmer in that area, because she was able to set some land aside for fallow in order to improve her yields. Because of that, her yields were probably better than what other farmers would have gotten at 60kgN/hectare. Since no other households used fertilizer at a rate greater than 40kgN/hectare, Figure 1 only shows yields at rates up to 40kgN/hectare and using 60kgN/hectare was allowed only for this particular household LP.

Figure 1: Fertilizer response of local and hybrid maize



One large problem in Malawi has been the devaluation of the Kwacha. At the time of this research in 1998, the exchange rate was K27/US$. Two months later, the rate had gone to K44/US$. By the summer of 2001, the rate had dropped to K80/US$. Recently, the Kwacha has again been appreciating, and is currently at K62/US$. Household simulations were completed at both "pre-devaluation" (K27/US$) prices and at current prices (K62/US$). Table 8 shows the difference in the two prices.

The prices for crops sold at the market were less than the prices of purchasing the same crops. This was because the households studied were selling these crops for only 26% of the market price, on average. Updated selling prices for these crops were calculated as 26% of the updated market price. The price for tobacco was a problem, however, as farmers gave varied numbers for the price that they received for selling tobacco.[20] Farmers were paid by middlemen who took the tobacco to the auction floor, and smallholders were not sure how much they would receive until after the middlemen sold the tobacco. However, since the price of tobacco is tied to the dollar, the tobacco selling price was increased accordingly, from K20/kg (the price the researcher found in 1998) to K45/kg. This may be a higher amount than farmers are actually receiving.

Table 9 shows updated income figures that were estimated using income information from more recent research.[21] Household expenses were increased at approximately the same rate as the food prices had increased (about 35%).

Table 8: Pre-Devaluation Prices vs. Current Prices

	Purchasing Price (K/kg)		Selling Price (K/kg)		Price of Inputs (K/ha grown)	
Crops:	1998 Prices	Current Prices	1998 Prices	Current Prices	1998 Prices	Current Prices
Local maize	7.6	10.0	2.3	2.6	-	-
Hybrid maize	7.6	10.0	2.3	2.6	550	2875
Groundnuts	41.5	64.0	10.0	16.6	150	225
Beans	27.1	41.4	10.0	10.8	150	225
Pigeon Peas	25.25	34.1	5.0	8.9	-	-
Cowpeas	31.1	42	4.0	10.9	-	-
Cassava	5.0	8.0	1.5	2.0	-	-
Sweet Potatoes	5.0	8.0	1.7	2.0	-	-
Tobacco	-	-	20.0	45.0	200	1390
Fertilizer (CAN), 50kg	445	680	-	-	-	-

Table 9: Income generating activities

Income Generating Activities	1998 K/hour	Current K/hour
Ganyu	2.5	3.0
Informal sector small business	8.3	10.0
Formal sector job	10.0	12.5

HOUSEHOLD INFORMATION

Five of the households chosen for modeling were poor households-three FHHs and two MHHs. Two households chosen were at the higher end of the income strata among those households surveyed; however, these two households were not rich, just in a better situation than their counterparts. One household was a MHH and one a FHH.

Since all households surveyed would be considered poor by developed country standards, the researcher made distinctions between "poor" and "non-poor" (or less poor) mainly on the basis of food security attainment and household income. A food-insecure household would automatically be in the poorest category. Also, households that were food-secure, but earned less than $100 per person in the household per year were also considered to be "poor." Some other indicators that the researcher used to determine economic status were the following. Is the house made of mud or brick? Does the household hire *ganyu* labor or do they hire themselves out to do *ganyu* labor? Does the household hire any house servants? At what age do the children begin working on the farm (since younger children working the farm seems to indicate a tighter cash flow and inability to hire labor)? How much money does the household spend each month on non-food items? What type of non-food items do they buy-only essentials or extras? Along with food security and income information, these questions helped the researcher to determine the approximate economic status of the household.

The first MHH (MHH1) had only young children. The household consisted of a husband, a wife, a five-year-old son and a three-year-old daughter. This household farmed one hectare. They grew both local and hybrid maize intercropped with cassava and pulses. They fertilized their maize at a rate between 10 and 20kg N/hectare. The husband participated in *ganyu* work year-round, earning K500/month. The household cash requirements for non-food items were K50 per month, and the household required about 640kg of maize for the year to be food-secure, according to World Health Organization (WHO) nutritional requirements.

The next MHH (MHH2) consisted of a husband; a wife; two boys, ages thirteen and eight; and two girls, ages six and three. This household grew both local and hybrid maize with intercropped cassava and pulses, fertilized at a rate of 25kg N/hectare. Their farm was 0.8 hectares. The husband had an informal-sector job in town, and he earned about K1000/month. The household cash requirements totaled K200 per month, and the household required approximately 995kg of maize for a year.

The first FHH (FHH1) had no children in the labor pool; the household consisted only of the woman and her nine-month-old son. She had an extremely small farm, only 0.06 hectares. She grew both local and hybrid maize, intercropped with cassava and pulses, with 40kg N/hectare. The application rate of fertilizer was high because her farm was extremely small, so a very small application of fertilizer resulted in a large nitrogen rate per hectare. This household head participated in *ganyu* work in April, May, and June for 65 hours each month, earning about K165/month worked. She also received a small remittance of about K75/month from a relative. Her household required K40/month for expenses, and about 200kg of maize each year to be food-secure.

The next FHH (FHH2) consisted of the female head of the household and her two daughters, age 25 and 20. (She had had several other children, but they had recently died.) They grew 0.5 hectares of local maize intercropped with cassava and pulses. They applied about 20kg N/hectare of fertilizer to their maize. The head of the household sold firewood for income on some Saturdays, and she earned about K240/month. Household expenses totaled approximately K70/month, and food requirements were 695kg of maize per year.

The final low-income FHH (FHH3) consisted of the female household head, her 22-year-old brother, her 16-year-old son, and her two daughters who were nine and two years old. They farmed 0.2 hectares and grew hybrid and local maize intercropped with cassava and pulses. This household used no fertilizer. The household head and her son sold firewood on Saturdays, earning about K400/month. The household required K75/month for household expenses, and required about 1000kg of maize per year to be food-secure, according to WHO nutritional requirements.

The higher income MHH (MHHA) consisted of the male head of the household, his wife, and two sons, ages four and two. They grew 0.75 hectares of local maize intercropped with cassava and pulses. They fertilized at a rate of 25kg N/hectare. Both the husband and wife were teachers, earning a combined income of about K3200/month. Household expenses totaled K350/month; food requirements for the household were 815kg of maize per year.

The higher income FHH (FHHA) consisted of the female head; her daughter, age 30; three grandsons, ages 15, 13, and 12; one granddaughter, age 18; and two orphaned boys who lived with the family, ages 14 and 12. They grew 0.3 hectares of both local and hybrid maize, intercropped with cassava and pulses, fertilized at a rate of 60kg N/hectare. They had 0.25 hectares in fallow to improve maize yields. This female head had two older sons who brought income into the household. One son had a business, bringing K1300/month into the household. The other son sent a remittance of about K500/month to help with household expenses. The household had about K1200/month in expenses, and required 1710kg of maize each year.

HOUSEHOLD MODELS AND OPTIONS TESTED

These households were first modeled in LPs with pre-devaluation prices; next, households were modeled with current prices to see the difference the devaluation made in these households. After that, several options were introduced into the models for the five poorer households in order to test their value in improving household food security at current prices.

The differences between the solutions for pre-devaluation prices and current prices can be seen in Tables 10 and 11. Although activities performed and crops grown in each household do not change significantly, there are some very important differences in the outcomes. In the original, pre-devaluation, prices, all of the MHHs are able to meet household food and cash requirements. However, three of the four FHHs are not able to meet all food and cash requirements; only 75% of their food requirements for the year are met. FHHA is able to meet all requirements. Using the new prices, two of the three MHHs are still able to meet all requirements; however, they both have significantly less cash left at the end of the year for discretionary purchases. Although FHHA is a higher income household, it is still only able to meet 50% of the food needs for the household with the current prices. However, this is better than the other FHHs, who all are only able to meet 25% of household food requirements. The two higher income households, MHHA and FHHA, are clearly less affected by the price changes than the other households. All of the FHHs had more difficulty surviving the devaluation than did their counterpart MHHs.

Table 10: Pre-Devaluation Prices vs. Current Prices: MHHs

	MHH1		MHH2		MHHA	
Prices:	1998	Now	1998	Now	1998	Now
Food Requirement Met:	100%	75%	100%	100%	100%	100%
Activities						

Local maize-0kgN/ha (ha grown)	-	-	-	-	-	-
Local maize-10kgN/ha	-	0.30	-	-	-	-
Local maize-20kgN/ha	1.00	0.70	0.80	0.60	0.27	0.20
Local maize-40kgN/ha	-	-	-	0.20	-	0.40
Local maize-60kgN/ha	-	-	-	-	-	-
Hybrid maize-0kgN/ha (ha grown)	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	0.12	-
Hybrid maize--60kgN/ha	-	-	-	-	-	-
Total maize purchased	280	98	706	672	500	401
Avg. hrs/mo of male cash activity	150	150	120	120	120	120
Avg. hrs/mo of female cash activity	-	-	-	-	120	93
Cash earned per month--male	500	600	1000	1250	1600	2000
Cash earned per month--female	-	-	-	-	1600	2000
Remittance K/mo.	-	-	-	-	-	-
Fertilizer Purchased (kg)	100	85	80	100	50	100
Total ending cash (K)	3077	3878	6952	4185	21814	21760
Total ending cash (US$)	114	63	258	68	808	351

Table 11: Pre-Devaluation Prices vs. Current Prices: FHHs

	FHH1		FHH2		FHH3		FHHA	
Prices:	1998	Now	1998	Now	1998	Now	1998	Now
Food Requirement Met:	75%	25%	75%	25%	75%	25%	100%	50%
Activities								
Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-
Local maize-10kgN/ha	-	-	-	0.50	-	-	-	-
Local maize-20kgN/ha	0.06	0.02	0.50	-	0.20	0.20	-	-
Local maize-40kgN/ha	-	0.04	-	-	-	-	-	-
Local maize-60kgN/ha	-	-	-	-	-	-	-	-
Hybrid maize-0kgN/ha (ha grown)	-	-	-	-	-	-	-	-

Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-
Hybrid maize--60kgN/ha	-	-	-	-	-	-	0.30	0.30
Total maize purchased	122	18	242	-	857	132	1097	313
Avg. hrs/mo of male cash activity	-	-	-	-	20	20	160	160
Avg. hrs/mo of female cash activity	16	16	20	20	20	20	-	-
Cash earned per month-male	-	-	-	-	-	-	-	-
Cash earned per month-female	41	54	200	240	400	480	1300	1600
Remittance K/mo.	75	90	-	-	-	-	500	600
Fertilizer Purchased (kg)	5	10	50	25	20	20	100	100
Total ending cash (K)	527	933	1007	6334	161	3096	4223	3146
Total ending cash (US$)	20	15	37	102	6	50	156	51

In order to deal with these changes, households will no doubt adopt different strategies of coping. In this paper, five options to deal with these changes have been introduced into each of the five low-income households. The first two represent intervention from an outside organization, governmental or NGO. These options are a maize safety net and a fertilizer safety net. The last three options each introduce a different income-generating activity: growing tobacco as a cash crop; increasing hours of off-farm work; and taking out a loan for a small business.

The first option introduced is a maize safety net (50kg of maize), simulating a food relief program. Table 12 shows the difference between this option ("maize net") and the simulation with current prices and no intervention ("none"). This option increases food security some for the FHHs. All three FHHs are now able to meet 50% of their household food requirements; however, they are still chronically food-insecure. Both MHHs are in a slightly better situation as well.

Table 12: Maize Safety Net

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Maize Net	None	Maize Net	None	Maize Net	None	Maize Net	None	Maize Net
Food Requirement Met:	75%	75%	100%	100%	25%	50%	25%	50%	25%	50%
Activities										

Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	0.30	-	-	-	-	0.50	0.30	-	-
Local maize--20kgN/ha	0.70	0.70	0.60	0.60	0.02	0.02	-	0.20	0.20	0.20
Local maize--40kgN/ha	-	-	0.20	0.20	0.04	0.04	-	-	-	-
Hybrid maize--0kgN/ha(ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	48	672	622	18	15	0	49	132	328
Avg. hrs/mo of male cash activity	150	150	120	120	-	-	-	-	20	20
Avg. hrs/mo, female cash activity	-	-	-	-	16	16	20	20	20	20
Cash earned per month-male	600	600	1250	1250	-	-	-	-	-	-
Cash earned per month-female	-	-	-	-	54	54	240	240	480	480
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	85	100	100	10	10	25	35	20	20
Total ending cash (K)	3878	4378	4185	4685	933	932	6334	5432	3096	1136
Total ending cash (US$)	63	71	67	76	15	15	102	88	50	18

The fertilizer safety net ("fert. net") also simulates a relief program, giving 25kg of fertilizer to each household. This option marginally improves the situation of all households, but it does not make a substantial improvement (see Table 13). The maize safety net improves the situation more than the fertilizer safety net. This is likely because the increase in the cost of hybrid seeds has made it difficult for these farmers to purchase hybrid seeds. Although extra fertilizer is helpful in improving yields for local maize, it does not improve local yields as much as hybrid yields. An addition of a small amount of hybrid maize seed to the safety net (as was done in the starter packs distributed recently in Malawi) would likely improve food security substantially more than the fertilizer alone.

Table 13: Fertilizer Safety Net

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Fert. Net	None	Fert. Net	None	Fert. Net	None	Fert. Net	None	Fert. Net

Food Requirement Met:	75%	75%	100%	100%	25%	25%	25%	25%	25%	50%
Activities										
Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	-	-	-	-	-	0.50	0.50	-	-
Local maize--20kgN/ha	0.70	1.00	0.60	0.35	0.02	-	-	-	0.20	0.15
Local maize--40kgN/ha	-	-	0.20	0.45	0.04	0.06	-	-	-	0.05
Hybrid maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	63	672	644	18	16	-	-	132	373
Avg. hrs/mo of male cash activity	150	150	120	120	-	-	-	-	20	20
Avg. hrs/mo of female cash activity	-	-	-	-	16	16	20	20	20	20
Cash earned per month-male	600	600	1250	1250	-	-	-	-	-	-
Cash earned per month-female	-	-	-	-	54	54	240	240	480	480
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	75	100	100	10	-	25	-	20	-
kg fert used from 25 safety net	-	25	-	25	-	12	-	25	-	25
Total ending cash (K)	3878	4368	4185	4460	933	1091	6334	6674	3096	963
Total ending cash (US$)	63	70	67	72	15	18	102	108	50	16

Although the fertilizer would be helpful to farmers, some farmers may sell the fertilizer if they are in a financial difficulty. The problem is that they typically will sell it for much less than its value. Some Malawian farmers were observed to be selling their starter packs for K150-200 even though the packs were valued at K450 (Gough, personal communication 2001). They were selling the fertilizer, 5kg of "23:21 0+4S" and 10kg of urea, for K100.

The next option examined how the households would fare if they sold the fertilizer that they were given. The selling price for the fertilizer was set at K100, even though they would be selling 25kg of fertilizer, since this option was considering CAN fertilizer, which is less valuable than "23:21" or urea. This simulation shows that the money may help the households in the short run; however, over the course of a year, the households are basically not any better off than if they were not given the fertilizer (see Table 14).

Table 14: Fertilizer Safety Net and Selling Fertilizer

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Sell Fert. Net	None	Sell Fert. Net	None	Sell Fert. Net	None	Sell Fert. Net	None	Sell Fert. Net
Food Requirement Met:	75%	75%	100%	100%	25%	25%	25%	25%	25%	25%
Activities										
Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	0.30	-	-	-	-	0.50	0.50	-	-
Local maize--20kgN/ha	0.70	0.70	0.60	0.60	0.02	0.02	-	-	0.20	0.20
Local maize--40kgN/ha	-	-	0.20	0.20	0.04	0.04	-	-	-	-
Hybrid maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	98	672	672	18	18	-	-	132	132
Avg. hrs/mo of male cash activity	150	150	120	120	-	-	-	-	20	20
Avg. hrs/mo of female cash activity	-	-	-	-	16	16	20	20	20	20
Cash earned per month-male	600	600	1250	1250	-	-	-	-	-	-
Cash earned per month-female	-	-	-	-	54	54	240	240	480	480
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	85	100	100	10	10	25	25	20	20
Fertilizer sold (kg)	-	25	-	25	-	25	-	25	-	25
Total ending cash (K)	3878	3978	4185	4285	933	1033	6334	6434	3096	3196
Total ending cash (US$)	63	64	67	69	15	17	102	104	50	52

The final three options tested implementing specific changes to the households' livelihood systems. The first change tested was introducing a tobacco loan option into the system. This allowed farmers to take out a loan for fertilizer to grow tobacco. The model simulates the households repaying the loan at 35% interest by selling the tobacco. Any tobacco left over after repaying the loan is "sold" for cash for the household. This tobacco sale is noted in Table 15.

In this simulation, both MHHs "choose" to take out a loan and grow tobacco. This improves the situation of both households, although MHH1 is still not food-secure. Two of the three FHHs "choose" to grow tobacco. Both of these households (FHH2 and FHH3) are now able to meet 50% of their household nutritional needs instead of only 25%. FHH1 does not grow tobacco in this simulation, probably due to a lack of land and labor.

It is interesting to note that the two FHHs who chose to grow tobacco, as well as one of the MHHs took out a loan to grow a specific area of tobacco (0.3 ha for FH2, 0.12ha for FHH3, and 0.08ha for MHH1) and then only grew tobacco on about half that amount of land. The fertilizer saved from doing this was applied to maize. These households were helped by the cash from tobacco sold as well as from the extra maize yield.

Comparing the differences between the amount of improvement that the MHHs experienced from this option and the amount of improvement for the FHHs is difficult, since 50% of nutritional requirements will mean different amounts of calories for different household compositions. However, the researcher attempted to measure the total gain each household achieved from this option, converting extra food purchased or grown to a dollar amount. When these numbers were compared for this scenario, there was no real difference between the gain for MHHs and the gain for FHHs. (See Figure 2.)

Table 15: Tobacco Loan Option

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Tob. Credit	None	Tob. Credit	None	Tob. Credit	None	Tob. Credit	None	Tob. Credit
Food Requirement Met:	75%	75%	100%	100%	25%	25%	25%	50%	25%	50%
Activities										
Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	-	-	-	-	-	0.50	-	-	-
Local maize--20kgN/ha	0.70	0.95	0.60	0.23	0.02	0.02	-	-	0.20	-
Local maize--40kgN/ha	-	-	0.20	0.39	0.04	0.04	-	0.34	-	0.13
Hybrid maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	83	672	745	18	18	-	90	132	380
Tobacco credit (for X no. of ha)	-	.08	-	0.19	-	-	-	0.30	-	0.12
Tobacco--ha grown	-	.05	-	0.19	-	-	-	0.16	-	0.07
Tob. Kg sold after loan repayment	-	32	-	147	-	-	-	101	-	49
Avg. hrs/mo of male cash activity	150	150	120	120	-	-	-	-	20	20

Avg. hrs/mo of female cash activity	-	-	-	-	16	16	20	20	20	20
Cash earned per month-male	600	600	1250	1250	-	-	-	-	-	-
Cash earned per month-female	-	-	-	-	54	54	240	240	480	480
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	80	100	100	10	10	25	-	20	-
Total ending cash (K)	3878	4555	4185	8094	933	933	6334	7794	3096	1691
Total ending cash (US$)	63	73	67	130	15	15	102	126	50	27

Allowing household members to participate in increased off-farm work improves the situation for all five households, as shown in Table 16. This option allows FHH2, FHH3, MHH1, and MHH3 to work 20% more hours each month, since these households work off-farm almost year round. FHH1 only works 3 months out of the year in *ganyu*, so increasing her off-farm work is simulated by allowing her to work 5 months out of the year in *ganyu*. All three FHHs are raised to being able to meet 50% of their food requirements-not food secure, but closer to it. The MHHs are also helped by the extra off-farm work. The increased off-farm work does not seem to be more helpful for one household type than the other.

Table 16: Increased Off-Farm Work

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Off-Farm Work	None	Off-Farm Work	None	Off-Farm Work	None	Off-Farm Work	None	Off-Farm Work
Food Requirement Met:	75%	100%	100%	100%	25%	50%	25%	50%	25%	50%
Activities										
Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	-	-	-	-	-	0.50	-	-	-
Local maize--20kgN/ha	0.70	1.00	0.60	0.60	0.02	0.02	-	0.50	0.20	0.20
Local maize--40kgN/ha	-	-	0.20	0.20	0.04	0.04	-	-	-	-
Hybrid maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	236	672	672	18	65	-	64	132	378

Avg. hrs/mo, male cash activity	150	180	120	144	-	-	-	-	20	24
Avg. hrs/mo, female cash activity	-	-	-	-	16	27	20	24	20	24
Cash earned per month-male	600	720	1250	1440	-	-	-	-	-	-
Cash earned per month-female	-	-	-	-	54	81	240	288	480	576
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	100	100	100	10	10	25	50	20	20
Total ending cash (K)	3878	3117	4185	7065	933	822	6334	5658	3096	1788
Total ending cash (US$)	63	50	67	114	15	13	102	91	50	29

The final option introduces credit for a small business into the household. The business requires a K1920 loan at the beginning of the year, repaid at the end of the year with 35% interest. The business is modeled to pay K400/month for 50 hours of labor per month, K800/month for 100 hours of labor, and K1200/month for 150 hours of labor. In the simulation, the three FHHs are all restricted to a maximum of 100 hours/month, because they are currently working much less than that, and they have other household responsibilities. In the simulation for MHH1, the husband is allowed to work up to 150 hours/month, since he is working that many hours already. In these four households, working *ganyu* labor or other informal work in addition to the new small business was not permitted in the LP. Although the LP may find enough labor for the household members to continue to perform their old off-farm work as well, in reality, households would not be likely to do this. In MHH2, the husband already has an informal job that earns more money than the credit business option, so the loan is introduced as an option for his wife. She "chooses" to work only 42 hours/month for the business, while the husband continues to work at his old business.

This option improves all the households' situations, as shown in Table 17. Two of the three FHHs are now food-secure, meeting 100% of their food requirements. The third FHH is able to meet 50% of her requirements. Both MHHs are food secure and both are helped by this option. Again, no real difference is seen between the amount of improvement for MHHs verses FHHs.

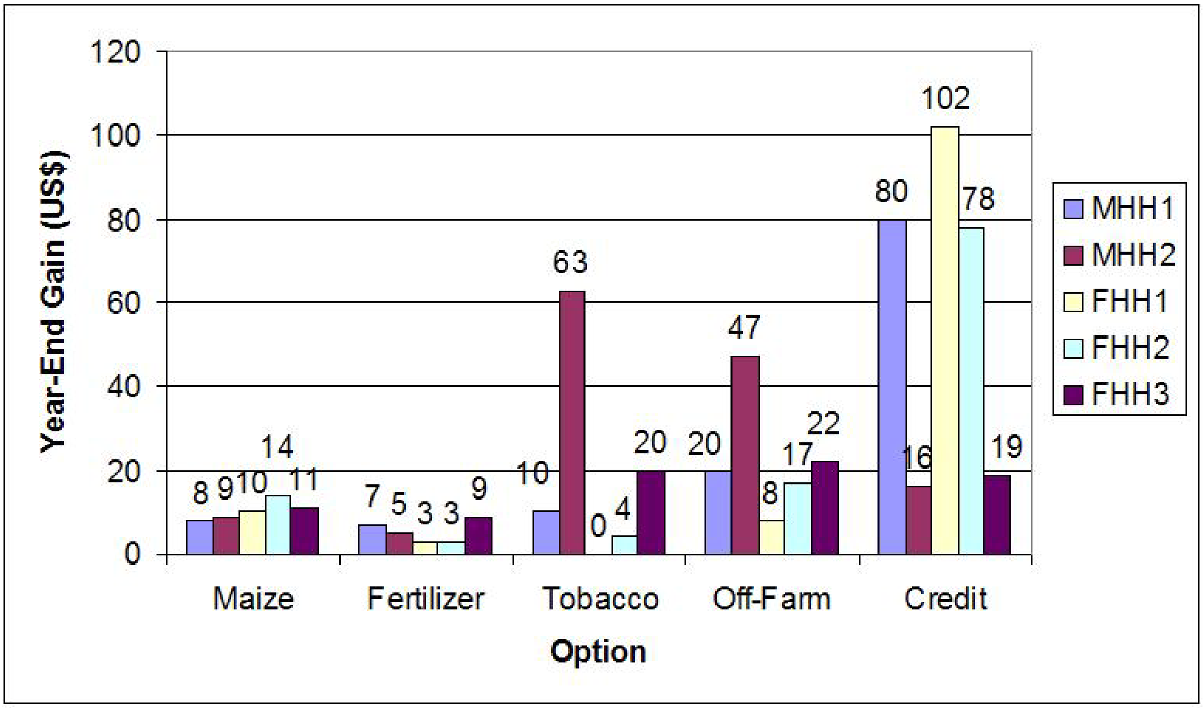
Table 17: Credit for a Small Business

	MHH1		MHH2		FHH1		FHH2		FHH3	
Option Tested:	None	Small Bus. Credit	None	Small Bus. Credit	None	Small Bus. Credit	None	Small Bus. Credit	None	Small Bus. Credit
Food Requirement Met:	75%	100%	100%	100%	25%	100%	25%	100%	25%	50%
Activities										

Local maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Local maize--10kgN/ha	0.30	-	-	-	-	-	0.50	-	-	-
Local maize--20kgN/ha	0.70	1.00	0.60	0.20	0.02	-	-	0.50	0.20	0.09
Local maize--40kgN/ha	-	-	0.20	0.40	0.04	0.06	-	-	-	0.08
Hybrid maize--0kgN/ha (ha grown)	-	-	-	-	-	-	-	-	-	-
Hybrid maize--10kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--20kgN/ha	-	-	-	-	-	-	-	-	-	-
Hybrid maize--40kgN/ha	-	-	-	-	-	-	-	-	-	-
Total maize purchased	98	236	672	752	18	175	-	336	132	386
Avg. hrs/mo, male cash activity	150	-	120	120	-	-	-	-	20	-
Avg. hrs/mo, female cash activity	-	-	-	-	16	-	20	-	20	-
Avg. hrs/mo for business-male	-	150	-	-	-	-	-	-	-	-
Avg. hrs/mo for business-female	-	-	-	50	-	100	-	100	-	100
Cash earned per month-male	600	1200	1250	1250	-	-	-	-	-	-
Cash earned per month-female	-	-	-	336	54	800	240	800	480	800
Remittance K/mo.	-	-	-	-	90	90	-	-	-	-
Fertilizer Purchased (kg)	85	100	100	100	10	25	25	50	20	25
Total ending cash (K)	3878	6802	4185	5176	933	5404	6334	5957	3096	1633
Total ending cash (US$)	63	110	67	83	15	87	102	96	50	26

Figure 2 is a summary chart of the amount of improvement each household received from each option. To make comparisons easier, increases in food security have been converted to dollar amounts of food that would have been purchased. Any extra money as a result of the option was added to that amount. In this way, comparing an option which increased FHH1 from 25% to 50% food secure can easily be compared with an option which did not increase the food security of MHH1, but increased the household's cash left at the end of the year. The chart represents the total amount of household improvement from each option.

Figure 2: Amount of gain from each option



DISCUSSION OF LP RESULTS AND CONSTRAINTS TO IMPLEMENTING OPTIONS

The differences between the simulations run at 1998 prices and current prices show that the devaluation of the Kwacha has likely been harmful to smallholder farmers in the Malosa area. The simulations show that food security has probably decreased greatly by this change. FHHs especially would be affected, because they have smaller landholdings and lower paying off-farm work. Households with increased income opportunities (such as MHHA and FHHA) would be less affected by these changes.

Of the three household intervention options-growing tobacco, increased off-farm work, and a loan for a small business-the loan for a business appears to increase household food security the most. Increased off-farm work could also be helpful in increasing food security. The tobacco loan option was also able to improve food security a good deal for some households.

Although growing tobacco seems to have the potential to improve household food security, the researcher found a few basic drawbacks to growing tobacco. The first is that tobacco requires a great deal of labor, and households (especially small households) often have to hire labor to grow tobacco. The second problem is the large start-up cost associated with tobacco. Although farmers are able to take out a loan to cover these expenses, many still do not wish to incur this expense. The third problem with tobacco is that in order to grow tobacco, a farmer must belong to a tobacco club, which requires the farmer to grow at least 0.1ha of tobacco, and requires the farmer to pay club fees. The variation in the price received after the tobacco is taken to the auction floor is a final drawback. Several of the households interviewed indicated that they did not want to grow tobacco because it required too much labor.

Increasing off-farm work appears to be a good strategy for increasing food security in the Malosa area. However, during the study, the most frequently cited reason for not participating in more off-farm work, and in particular *ganyu* labor, was that work was scarce. If more work were available, this would be a fairly easy opportunity to raise a household's food security and year-end cash. Bringing formal employment into the area may primarily help MHHs, since very few FHHs are formally employed, so introducing new opportunities to participate in informal-sector work and small businesses may be a good way to help FHHs in the Malosa area.

According to the LP simulations, the option to use credit to start a small business was the best option tested for increasing food security. This option allows households to earn more cash for food purchase, and in the LP models, provides food security for all households except one. Having access to credit seems to have the potential to be beneficial to households of the Malosa area.

Although credit was the option that increased food security the most in the simulations, the field research showed that there were, in real life, a few drawbacks to this option. One was that it was difficult to gain access to a credit source. In order for a smallholder to obtain credit, he or she was required to belong to a credit club. Credit clubs often required fees and meeting participation. Another problem was that many people were afraid of credit. However, eight households surveyed who did not have credit stated that they would like to have credit to start a business. This shows that there are some households who would be interested in credit, and that credit, if made more widely available, could be an effective tool to raise households in this area into food security.

The safety net options were modeled to show the effect of a short-term intervention by an organization, either governmental or NGO. The maize safety net could give 50kg of maize to the household, while the fertilizer safety net could give 25kg of fertilizer to the household. Both options helped to increase food security, although the maize safety net improved food security to a greater extent.

RECOMMENDATIONS

There are four main recommendations arising from this research. The first is to continue making credit programs available to the rural poor in the Malosa area, taking care not to exclude FHHs. This option has the potential to improve household food security. The small business run by the son in FHHA was started by a small business loan. They have now had the business for 10 years and are much more food secure than the other three FHHs studied in this paper.

The second recommendation is to research the feasibility of smallholder farmers in the Malosa area using credit to grow tobacco. Research should be done to determine if farmers in this area would benefit in real life from planting tobacco on a small area of their land. Also, the willingness of farmers in the area to grow tobacco should be researched further.

The third recommendation is to research the possibility of introducing increased opportunities for off-farm work in rural areas. Households who participated in *ganyu* work often remarked that *ganyu* was scarce. Households selling firewood were only able to do so for about 10 hours each week (maximum), because there was a relatively fixed demand for firewood. Households need access to other types of off-farm income opportunities in the rural areas.

The final recommendation is to research providing safety nets to the poorest households in the short-run. Safety net programs can be productivity-enhancing programs, such as food-for-work or input-for-work programs. These are different than subsidizing prices, because they focus on the poorest households and do not disrupt the market.

Conclusion

Diversification of household activities is a key factor to household food security. In Malawi, farms are not large enough for households to be food secure from subsistence farming alone. Cash cropping and off-farm work are important parts of the system. In the area studied, off-farm income was highly important to the livelihood system. Households with more access to income generating activities, or access to higher paying work were more food secure than households who did not have these benefits. In particular, FHHs were more food insecure than MHHs because they had smaller land holdings, less labor available for on-farm and off-farm work, and lower paying off-farm work. Helping these households achieve food security will require more than just improving subsistence agriculture. Policy makers should complement the research aimed at improving agricultural yields of food and cash crops with programs focused on increasing the off-farm work available to smallholder farming households. Safety net programs, such as the starter pack program and food-for-work or input-for-work programs should continue to be encouraged for the poorest households.

Notes

1. CIA
2. Sahn and Arulpragasam
3. GOM and UNICEF
4. CIA
5. Gladwin et al.
6. GOM and UNICEF
7. GOM and UNICEF
8. Thompson and Metz
9. Gladwin and Thomson
10. Gladwin and Thomson
11. Hildebrand, 1998
12. Gladwin and Thomson
13. Commonwealth Secretariat
14. Spring, 1995

15. Spring, 1992
16. Gladwin and Thompson
17. Uttaro
18. Hildebrand, 2001
19. WHO
20. Gough
21. Gough

References

Central Intelligence Agency. (CIA). (1999). *The World Factbook 1999*. [On-line], Available: http://www.odci.gov/cia/publications/factbook/index.html

Commonwealth Secretariat. *Engendering adjustment for the 1990s: Report of a commonwealth expert group on women and structural adjustment.* London: Author, 1989.

Gladwin, Christina & Thompson, Anne. "Food vs. cash crops: Which is the key to food security for African women farmers?" Paper presented at the meetings of the American Anthropological Association, Washington, DC, and the International Association of Agricultural Economists, Sacramento, CA, 1997.

Gladwin, Christina, Thomson, Anne, Peterson, Jennifer, & Anderson, Andrea. "Addressing food security in Africa via multiple livelihood strategies of women farmers." *Food Policy* 26 (2001): 177-207.

Gough, Amy. Personal communication. November 2001.

Government of Malawi (GOM) and United Nations Children's Fund (UNICEF). *The situation of women and children in Malawi.* Lilongwe, Malawi: GOM and UNICEF, 1987.

Hildebrand, Peter. *The challenge of diversity: Modeling smallholder livelihood systems with ethnographic linear programming.* Boulder, CO: Lynne Reinner Press, 2001.

Hildebrand, Peter. Personal communication. April 1998.

Spring, Anita. "Family structures and women headed families: Recognition and empowerment issues." Paper presented at the Nineteenth International Conference on the Unity of the Sciences, Seoul, Korea, 1991.

Spring, Anita. *Agricultural development and gender issues in Malawi.* Lanham, MD: University Press of America, 1995.

Thomson, A., & Metz, A. *Implications of economic policy for food security: A training manual.* Rome: Food and Agriculture Organization of the United Nations, 1997.

Uttaro, R.P. "Diminishing returns: Soil fertility, fertilizer, and the strategies of farmers in Zomba RDP, Southern Malawi." Unpublished manuscript. Gainesville: University of Florida, 1998.

World Heath Organization (WHO). "Energy and protein requirements." (Report of a joint FAO/WHO/UNU Expert Consultation). World Health Organization Technical Report Series 724. Geneva: Author, 1985.

Reference Style: The following is the suggested format for referencing this article: Anderson, Andrea. "Effect of Cash Cropping, Credit, and Household Composition on Food Security in Southern Malawi." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a7.htm

African Studies Quarterly | Volume 6, Issues 1 & 2 | Spring 2002

Vouchers versus Grants of Inputs: Evidence from Malawi's Starter Pack Program

AMY E. GOUGH, CHRISTINA H. GLADWIN, AND PETER E. HILDEBRAND

Abstract: The majority of Malawi's smallholders use low purchased-input technologies and as a result, produce low yields; 40 to 60 percent of rural households face chronic food insecurity for two to five months every year. These households are therefore in need of a program to increase their productivity and improve their food security. Such a program, entitled the "starter pack program," was initiated in 1998/99 by Malawi's Ministry of Agriculture in collaboration with donor agencies. The program aimed to distribute "starter packs" to all farming households, containing small packs of hybrid maize seed, fertilizer, and either groundnuts or soybeans. The 1999 starter pack distribution also included a pilot voucher project that distributed two different types of vouchers, in a test to see whether the vouchers received by some of the farmers were more effective than the packs received by other farmers. The purpose of this paper is to evaluate that test. We examine the differences between the three distribution systems of the starter pack, starter pack voucher, and flexi voucher, in order to determine which is the more effective tool for improving food security among Malawian smallholder farmers. We also determine if the impacts depend on particular household characteristics, including gender and marital status of the household head.

Introduction

Within the small African country of Malawi, agriculture provides employment for nearly 90% of all households, accounts for 40% of the GDP, and generates 77% of the revenue from Malawi's exports. [1] The Ministry of Agriculture estimates that 2,786,576 households are farming families. [2] The majority use low purchased-input technologies and as a result, produce low yields and experience food insecurity chronically, i.e., before the April harvest every year. In southern Malawi, 40 to 60 percent of rural households face chronic food insecurity for two to five months every year. [3] These households are therefore in need of a program with the potential to increase their productivity and improve their food security.

In both the 1998/1999 and 1999/2000 planting seasons, such a program -- entitled the "starter pack program" -- was initiated by the Ministry of Agriculture in collaboration with numerous international donor agencies. The program aimed to distribute "starter packs" to all farming households, containing small packs of hybrid maize seed, fertilizer, and either groundnuts or soybeans. The packs were intended to allow smallholders to plant 0.1 hectare of land with modern yield-increasing inputs including fertilizer. Additionally, the 1999 starter pack distribution included a pilot voucher project that distributed two different types of vouchers in a test to see whether a voucher distribution system was more effective than

http://www.africa.ufl.edu/asq/v6/v6i1-2a8.pdf

ISSN: 2152-2448

distribution of a bulky package of free inputs, and if so, which kind of voucher was more effective.

This paper aims to evaluate this test, and examine the differences between the three distribution systems of the starter pack, starter pack voucher, and flexi voucher, in order to determine which is the more effective tool for improving food security among Malawian smallholder farmers. We also analyze how the three alternative grant distribution systems impact rural households, and see if the impacts depend on particular household characteristics, including gender and marital status of the household head. A priori, we expect grants of starter packs to benefit female headed households (FHH) more than male headed households (MHH), because proportionately more FHHs are found in the poorest 40 percent of Malawi's population and are therefore more likely to be chronically food insecure. [4]

THE CURRENT PROBLEM OF FOOD INSECURITY IN MALAWI

Malawi is chronically food insecure, according to criteria adopted by the Food and Agricultural Organization of the United Nations (FAO). [5] They consider a country or region is food secure if "all human beings at all times have physical and economic access to the basic foods they need." [6] Clearly, Malawi does not meet these criteria. [7]

The problem of chronic food insecurity in Malawi is a result of numerous recent shocks and stresses to the livelihood systems of Malawi's rural smallholders. Shocks include severe droughts in 1991 and 1993 followed by the collapse of the credit system in 1994 and several debilitating devaluations of the Malawi Kwacha (MK). [8] Compounding these shocks are more routine but persistent stressors, which include annual population growth rates of 2.5 to 3 percent, increasing fertilizer prices, and as a result, depleted soils and low yields per hectare. These factors, along with social considerations such as the high incidence of HIV/AIDS, changing patterns in labor migration, and adaptations to the newly established market structure, have pushed farmers away from the sole activity of farming and towards secondary or tertiary nonfarm activities to improve food security.

Devaluations of Local Currency

During the 1999/2000 starter pack and voucher distribution, the Malawi Kwacha ranged from 38-48 per US $1.00. Agricultural input prices increased so much that a ten-kilogram bag of commonly planted Panner maize seed cost MK 595, a fifty-kilogram bag of urea fertilizer cost MK 825, and a fifty-kilogram bag of 23:21:0 +4s fertilizer cost MK 780. These increased prices forced smallholders to either abandon fertilizer purchases or drastically reduce them.

Increasing Population Density

Population pressures have reduced the amount of land available to smallholders. With many households in the southern region farming only 0.3 hectares or less, Malawi's most densely populated region has no land in natural fallow systems, as does its neighbor, eastern Zambia. Maize continuously cultivated on depleted soils with little to no soil amendments are the norm. [9] As Uttaro also shows here, smallholder farmers in areas close to urban centers such as Blantyre (in southern region), Lilongwe (in central region), and Mzuzu (in northern region) also face the problem of limited land availability due to high population densities.

Collapse of the Credit System

During the 1980s Malawi was a model for providing access to credit at low interest rates for African smallholders. [10] In 1994, however, with the transition in leadership from the near dictatorship of Dr. Kamuzu Banda to the multiparty system of Dr. Bakili Muluzi, economic changes resulted in rising default rates on credit repayments. During this time, interest rates that were subsidized at ten percent became unsubsidized at thirty to fifty percent. [11]

Fertilizer subsidies were additionally phased out during the 1980s and early 1990s as part of structural adjustment reforms. The removal of these subsidies, coupled with rising world fertilizer prices, decreased the profitability of fertilizing food crops. [12] Fertilizer use has therefore dropped significantly since 1994. [13]

Decreasing Yields

Compounding these factors is the problem of consistently decreasing yields of food and cash crops in the smallholder sector, caused by diminishing soil fertility. Farmers attribute the fall in the productivity of their land to the increased cost of inorganic fertilizers. [14] Coupled with their lack of access to credit for fertilizer, smallholders have minimal opportunities to increase their yields and intensify their agricultural production, contrary to Smale's optimistic claims that Malawi during the 1990s was on the verge of experiencing a "delayed Green Revolution." [15]

Faced with a crisis of chronic food insecurity, unheard of during the Banda years, Malawian smallholders in the early 1990s sought governmental assistance through food for work programs, welfare programs, and free input programs. Food security analysts repeatedly called for "safety net" programs. [16] Safety net programs function under the assumption that sustainability of a livelihood system depends upon increasing the resilience of the most marginal and poorest quintile(s) of the population. Interestingly, however, Malawi's starter pack program, first implemented in the 1998/1999 season and repeated in 1999/2000, was targeted at all subsistence farmers and not only the most marginal. Why?

THE STARTER PACK: A TOOL FOR HOUSEHOLD FOOD SECURITY

The suggestion for the starter pack program was presented in 1998 by Charles Mann, of Harvard Institute for International Development (HIID), who stated that national food security could be best achieved by distributing hybrid seed and fertilizer to *all* Malawian farmers. [17] The objectives of the starter pack distribution in 1999/2000 were: "a) to assist in filling the food gap; b) to promote crop diversification; and c) to promote the concept of soil fertility improvement". [18] With the intention of jump-starting yields, the program distributed five kilograms of urea fertilizer, ten kilograms of 23:21:0+4s fertilizer, two kilograms of groundnuts or soybeans, and two kilograms of hybrid maize seed to smallholders.

In addition, the 1999/2000 starter pack program included a pilot project designed to distribute up to 50,000 starter packs or other household items utilizing existing private-sector retail outlets. Selected households did not directly receive starter pack input packages, rather vouchers redeemable at local retailers. Forty-nine thousand of these vouchers were redeemable only for starter packs. The remaining 1,000 "flexi vouchers" could be redeemed for either a starter pack *or* goods valuing up to MK 450.00. [19] Subject to availability, flexi vouchers could be redeemed for soap, salt, oil, fertilizer (often limited in availability), hybrid maize seed, agricultural tools, pots and pans, blankets, lamps, or similar household items. Participating retail outlets varied between the southern, central, and northern regions. The purpose of the voucher pilot project was to "test the capability of the national retail chains to transport, store and distribute packs to recipients, and to examine the various modalities of distribution". [20] At three selected test sites, the pilot project tested the number of distributing outlets, timing of voucher distribution, and transportation of starter packs to retail outlets. The purpose of the flexi voucher was to test a third distribution method, in this case utilizing previously available goods instead of specially packaged and distributed starter packs.

RESEARCH METHODS AND OBJECTIVES

The primary purpose of this paper is to evaluate the differences in effectiveness of the starter pack, starter pack voucher, and flexi voucher as tools for improving food security among Malawian smallholder farmers. We assess whether the vouchers received by some of the farmers were more effective than the packs received by other farmers; and if so, which kind of voucher was more effective, starter pack voucher or flexi voucher.

If a particular type of starter pack input distribution method succeeds in enhancing food security within particular households during the years of distribution, it may hold potential as a safety net program. Further, if households demonstrate increases in productivity and/or discretionary cash in years *following* actual distribution of starter pack inputs, that input distribution method may also be a productivity-enhancing safety net or "PES-net." [21]

DATA COLLECTION

Detailed household information was collected from forty-seven households nationwide, who were chosen based on three criteria of geographic location, status as a recipient of starter pack inputs, and gender and marital status of the head of household. For example, 15 households were selected from the southern region, 17 from the central region, and 15 from the northern region. Households were also classified according to the type of inputs received through distribution of the 1999/2000 starter pack. Households interviewed consisted of 14 households receiving inputs in the form of an assembled starter pack; 9 households receiving a starter pack voucher; 12 households receiving a flexi-voucher; and 12 households who, although eligible, were unintentionally omitted from one of the above programs. [22] Households were also disaggregated by the gender of head of household, to understand the relationship between gender and marital status of the household head and the impact of the starter pack program. Fifteen female-headed households (FHHs), 20 men in male- headed households (MHHs), and 12 married women in male-headed households (MFs) were therefore interviewed.

DATA ANALYSIS: ETHNOGRAPHIC LINEAR PROGRAMMING

To determine the potential of the starter pack, households were simulated utilizing ethnographic linear programming. [23] Linear programs are designed to reflect the reality of the livelihood systems of each particular household, and can model considerable individual variation in resource availability and use. [24] The linear programming model, constructed in Microsoft EXCEL, includes assumptions about the labor, cash, and consumption requirements of the livelihood system, as well as the cash and labor constraints of commonly produced crops, and additional components of the livelihood system such as off-farm employment and receipt of remittances. The model evaluates options available to the individual household and predicts the land, labor, and activity allocation most optimal to maximize household discretionary cash income. Households here are modeled for a time period of seven years, first without any starter pack inputs and then after receiving inputs through each of the three distribution methods.

Once the model accurately simulates the reality of the household livelihood system, it is assumed that the model can also make accurate predictions of activity distribution upon introducing the starter pack or voucher inputs into the system. Analysis of predictions can effectively function as a tool to understand the potential benefit of vouchers versus grants of starter packs, through observation of differences in discretionary year-end cash and a household's ability to meet consumption requirements with the differential introduction of vouchers versus starter packs into the system. The models can also be used to categorize different kinds of households into "recommendation domains" according to shared characteristics. Particular household types, such as female-headed households, may benefit differently from male-headed households with a greater amount of land or more access to credit, fertilizer, or off-farm employment.

ASSUMPTIONS UTILIZED IN THE LINEAR PROGRAM

The primary activity presented to households modeled in the linear program was agricultural production. Predominant crops of local maize, hybrid maize, groundnuts, beans, and tobacco were included in the linear program. Households reporting access to a small garden plot of land (dimba) were modeled with the opportunity to plant a combination of vegetables and maize there.

Famine Early Warning System (FEWS) data provided baseline yield figures. FEWS nationwide yield figures for the 1999/2000 season were organized by Extension Planning Area (EPA), the same category used for distribution of starter pack and flexi vouchers. Average yield data for EPAs containing interviewed households were combined to create regional averages. With the use of Benson's data from the nationwide Fertilizer Verification Trials of 1995/96, these averaged yield figures were converted to reflect yields with varied amounts of fertilizer. [25]

The linear program model also included data on consumption needs of each household. Food and Agriculture Organization (FAO) consumption requirements for an adequate nutritional diet were utilized and cross-referenced with maize consumption data as reported by households during interviews. Suggested and reported maize requirements were found to be similar, indicating the validity of utilizing the FAO suggested requirements. In making this comparison, a program entitled Furnishing Essential Diets (FED) was utilized. [26] Each household members' age, sex, and physical activity level was used in collaboration with country specific averages for individual body weights to calculate energy requirements in kilocalories. Data collected during interviews were compared with the FED suggested consumption requirements. The two sources were found to be consistent with a correlation coefficient of 0.6540 and the use of FED was continued.

Using 1.0 to represent the total household kilocalorie requirements suggested by FED, we assumed that 0.7 of caloric intake was obtained from maize, 0.055 from beans, 0.02 from groundnuts, 0.034 from vegetables, and 0.191 from purchased items such as oil. We assumed that maize consumption was obtained through the locally prepared "nsima", calculated to contain 3168 kcals/kilogram (kg) or 12% less than the total kilocalorie content found in one kg of maize, in order to account for the portion lost during processing. [27] In addition, beans were assumed to contain 3320 kcals/kg, groundnuts 5536 kcals/kg (unshelled), and vegetables 350 kcals/kgs. Consumption requirements were adjusted as household members aged over the seven-year period.

The linear program provides predictions of the optimal scenarios for each of the 47 households with the ultimate objective of maximizing household discretionary cash income at the end of the year. The program calculates the cost and income of available activities and makes predictions of labor allocation, cropland distribution, and involvement in off-farm income generating activities, predicting that households will engage in those activities generating the greatest discretionary cash income.

While simulating households through the linear program, the primary objective remains maximizing household discretionary cash while meeting consumption requirements during the seven-year time period modeled. The linear program simulates maintainable household activities, and does not provide opportunity for activities such as thieving or decreased consumption. If these activities are necessary in order to meet cash or consumption requirements, as they commonly are for Malawian smallholders, households are considered food insecure. Because of this, many households in the linear program are unable to meet the designated cash and consumption requirements.

LINEAR PROGRAM SCENARIOS

All forty-seven households are simulated according to seven different linear program scenarios, each for a period of seven years. First, households are modeled while receiving no starter pack inputs. Next, households are modeled while receiving a starter pack for only the first two of the seven years (scenario 2), then with a starter pack voucher for only the first two of the seven years (scenario 3), and then with a flexi voucher for only the first two of the seven years (scenario 4). Finally, households are modeled while receiving a starter pack for the first five of the seven years (scenario 5), a starter pack voucher for the first five of the seven years (scenario 6), and then a flexi voucher for the first five of the seven years (scenario 7).

LINEAR PROGRAM RESULTS: PREDICTIONS WITHOUT STARTER PACK INPUTS

Household simulations with the first linear program scenario are evaluated here, and reveal the inability of most households to meet cash and consumption requirements for the seven year time period without any starter pack inputs. Results show only 14 of the 47 modeled households are able to meet cash and consumption requirements for the whole time period, implying they are the only households with "sustainable livelihood systems" over the seven-year time period. It is assumed here that households have "sustainable livelihood systems" as described in the sustainable livelihoods (SL) literature if they can satisfy cash and consumption requirements over the seven-year time period modeled. If not, if the model has an infeasible solution for at least one of the seven years modeled, this means the household cannot satisfy both cash and consumption requirements with the livelihood activities currently in the model. In this case, the livelihood system of the household is considered "unsustainable." Linear programming models are thus used here to quantify the ideas presented qualitatively in the sustainable livelihoods (SL) literature. [28]

The remaining 33 households (70%) are unable to meet full cash and consumption requirements. They are of particular interest as they represent severely food insecure households and examples of "unsustainable" livelihood systems. To determine the severity of the cash or food deficit of the remaining households, the stated cash and consumption requirements are reduced incrementally. By doing this, four groups of households are created:

Group One: Households able to meet full consumption and cash requirements,

Group Two: Households able to meet full consumption requirements and 50% of the cash requirements,

Group Three: Households able to meet 75% consumption requirements and 50% of the cash requirements,

Group Four: Households able to meet 66% consumption requirements and 50% of the cash requirements, while exhibiting negative year-end cash values, implying they are in debt. Allowing group-four households to dip into negative numbers reveals the extent of their inability to meet cash and consumption requirements and the size of their debt.

Although there may be some data inaccuracies, the need to reduce cash and consumption reflects the reality that many Malawian households do not now meet their consumption requirements through "accepted" livelihood activities, particularly in the pre-harvest season. Realities for chronically food insecure households would expectedly include begging, borrowing, or stealing.

DIFFERENCES BETWEEN THE FOUR GROUPS

Of the 47 modeled households, 17 (36%) are in group-four, representing the most impoverished households. To characterize households in group-four, this research looks for shared household characteristics by considering three possible criteria; gender of the head of household, geographic location, and available land.

A comparison of the gender characteristics in figure 1 shows that six of the 15 (40%) female-headed households interviewed are in group-four, versus 11 of the 32 (34%) male-headed households. Notably, of the total 15 female-headed households, only two (13%) are in group-one, whereas 21 male-headed households (38%) are in this group (figure 1). Results from scenario 1 thus show that more MHHs are in the richer group-one, while more FHHs are in the poorer groups, unable to provide their households with sustainable livelihoods without the starter pack.

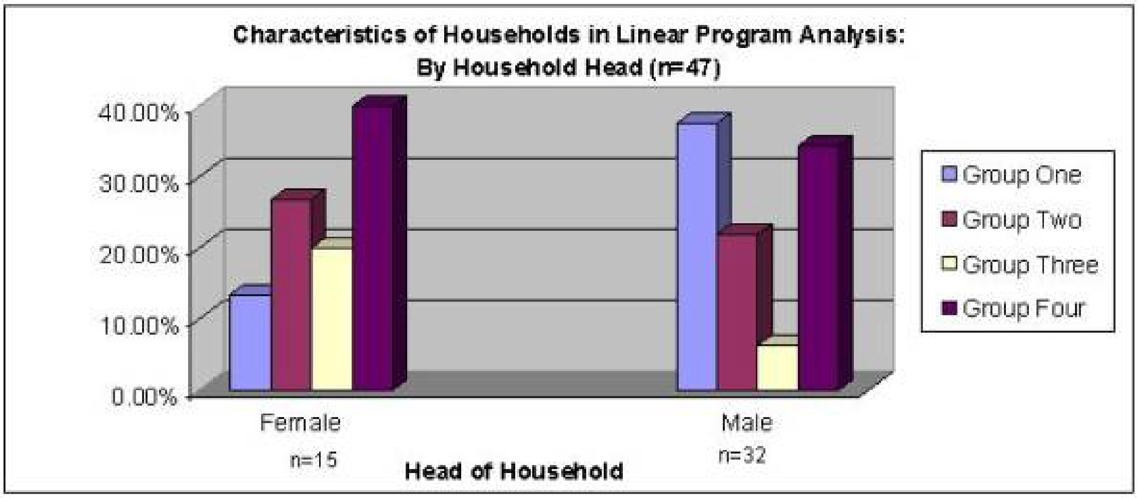


Figure 1: Characteristics of Households: By Household Head and Group

Results of evaluating geographic location in scenario 1 show that half of those in the poorest group-four come from the region of the greatest population density in Malawi, the southern region (figure 4). In contrast, the greatest proportion (41.18%) of households able to meet full requirements (group-one) live in the central region where Malawi's predominant cash crop of tobacco is produced. Households in the southern region are relatively worse off than northern households and in turn central households. In terms of available land, households in group-four have considerably less land than those in groups one through three. Only three of the 18 households in group-four have more than two acres of available land.

Potential of the Starter Pack for Household Food Security

Next, households are modeled while receiving a starter pack for only the first two of the seven years (scenario 2), then with a starter pack voucher for only the first two of the seven years (scenario 3), and then with a flexi voucher for only the first two of the seven years (scenario 4). Finally, households are modeled while receiving a starter pack for the first five of the seven years (scenario 5), a starter pack voucher for the first five of the seven years (scenario 6), and then a flexi voucher for the first five of the seven years (scenario 7). To analyze the impact of the starter pack inputs on household food security, two aspects are examined:

changes in year-end discretionary cash income earned by the household with the inputs or vouchers, and changes in maize produced by the household.

Changes in Year-End Cash Income with the Starter Pack

Overall results of introducing the starter pack via the various distribution methods (starter pack, starter pack voucher, and flexi voucher) are disappointing: a run of each model in scenarios 2-7 shows that predicted increases in a household's discretionary cash income are less than seven percent and thus not substantial (figure 2). Whether or not the household receives the input grants for two years or five years, out of a total seven years, makes little difference to these results: there is practically no increase in discretionary cash income over the control of "no starter pack." As shown by the flat graphs in figure 2, household average annual cash of sample households in Malawi's central region does not increase with starter pack inputs or vouchers.

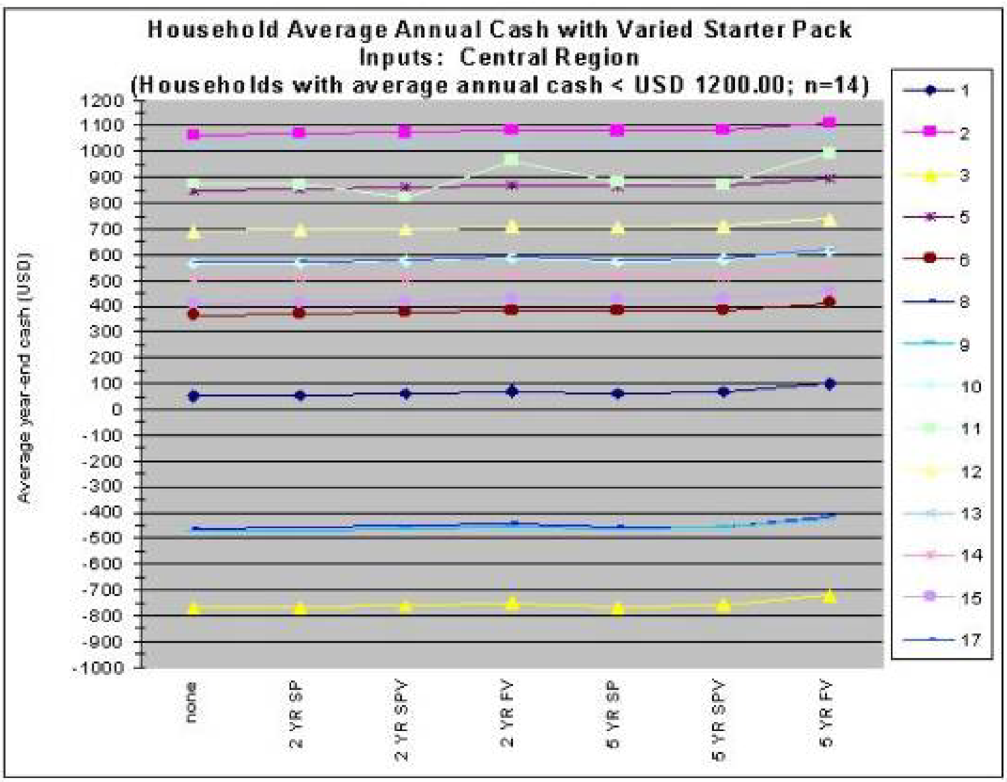


Figure 2: Average Annual Year-End Cash With Starter Pack Inputs: Central Region (Households with average annual cash < USD 1200.00)

However, the linear program predicts the greatest discretionary cash increase when households receive flexi vouchers (scenarios 4,7). Yet these results are also not encouraging for the starter pack. In all cases, the linear program predicts households redeem flexi vouchers for goods (soap, salt, etc.) rather than get a starter pack with the flexi voucher. Because the linear program considers the retail outlet value of the flexi voucher as a direct cash contribution to the household, redemption of flexi vouchers for goods provides an immediate cash value of MK 900 and MK 2250 when receiving flexi vouchers for two and five-years, respectively.

In scenarios 3 and 6, when households are provided with a starter pack voucher, the linear program applies these inputs directly to the household resource pool if it predicts the household redeems the voucher for inputs. Households can use or sell all or some of the inputs; e.g., they can keep the hybrid maize seed, use the fertilizer, and sell the legume seed. If households do not redeem the voucher, it can be sold informally for a value reportedly less than the value of selling the starter pack. The linear program therefore assumes transaction costs when acquiring a starter pack after receipt of a voucher.

Results show that households receiving starter pack vouchers earn an average annual cash income slightly less than those households receiving flexi vouchers and slightly greater than those households receiving starter packs. In scenario 6 with households receiving starter pack vouchers for five years, the linear program in most cases predicts households sell vouchers during the first two years and redeem vouchers for starter packs during the remaining three years. Reportedly, sales of vouchers provide the household with an immediate cash value between MK100 and MK300. In these cases, the cash benefit to households occurs primarily during the first two years when vouchers are sold. In other cases, particularly in the northern region, the model predicts households redeem vouchers for starter packs in all years, resulting in annual discretionary cash averages similar to those exhibited with starter pack distribution in scenarios 2 and 5. [29]

Results show that distribution of assembled starter packs (scenarios 2, 5) demonstrates the smallest comparative increase in total year-end cash income with the grants program. Similar to scenarios 3 and 6 with receipt of a starter pack voucher, receipt of a starter pack in scenarios 2 and 5 does not consistently add cash income to the household. In some cases, the increase in household discretionary cash after receiving five years of an assembled starter pack is less than the cash increase after receiving only two years of flexi vouchers. With the two-year value of flexi vouchers equivalent to MK 900, the five-year starter pack value is then less than MK 900, or MK180 annually. Some households sell part of the pack, use only the fertilizer, and save the rest. The increase in household cash income is thus quite variable, depending on how the household utilizes the inputs and whether or not it sells, plants, trades, or saves them.

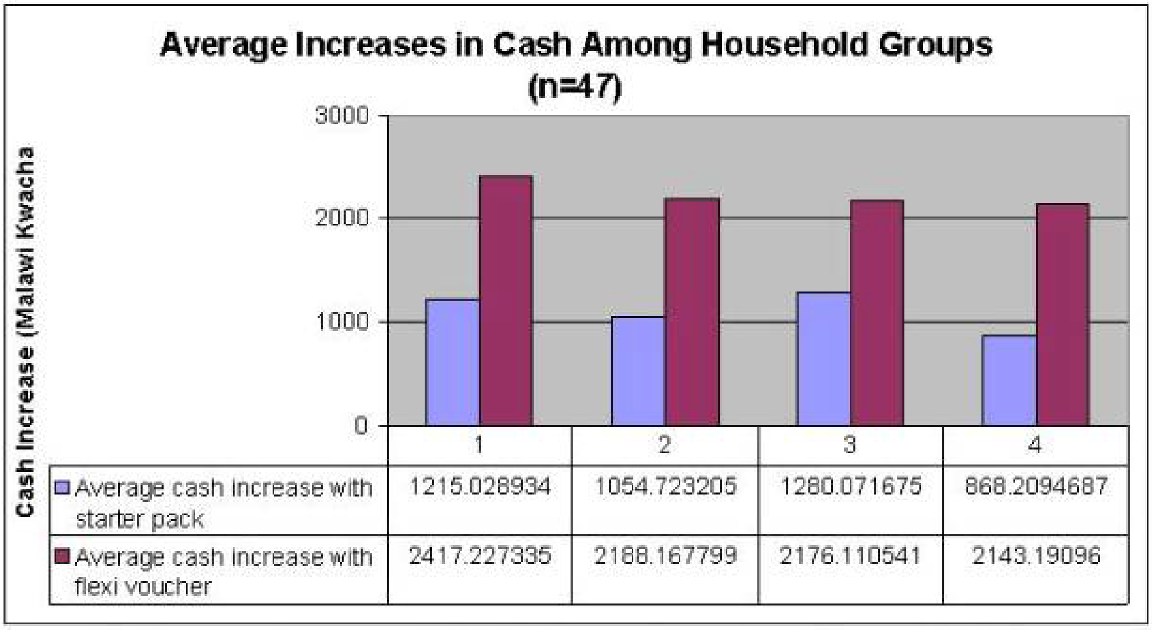


Figure 3: Average Increases in Cash Among Household Groups (n=47)

These results do not paint a rosy picture of the benefits of the starter pack program, at least in the way it was universally distributed to all smallholder farms in Malawi in 1998 and1999. Does the picture improve somewhat if we look only at the benefits accruing to the poorest group-four, the group that Gladwin's introduction to these papers claim should have been the only group targeted with a safety net program? Figures 3 and 4 show the results disaggregated by the household grouping described above, where group-one is the richest group with sustainable livelihood systems and group-four is the poorest group with unsustainable livelihood systems. The disaggregated results in figure 3 show households in group-four increase their cash incomes by less than MK 1000 with receipt of the starter pack, versus MK 2143 with the flexi voucher. Of all the groups, group-four achieves the largest percentage increase in household cash income after five years of starter pack inputs, but this is a paultry 3.47% (figure 4). This minimal increase is doubled to 6.5% with the flexi voucher. Both increases in cash income, however, are small and do not provide much support for the starter pack program in its present form.

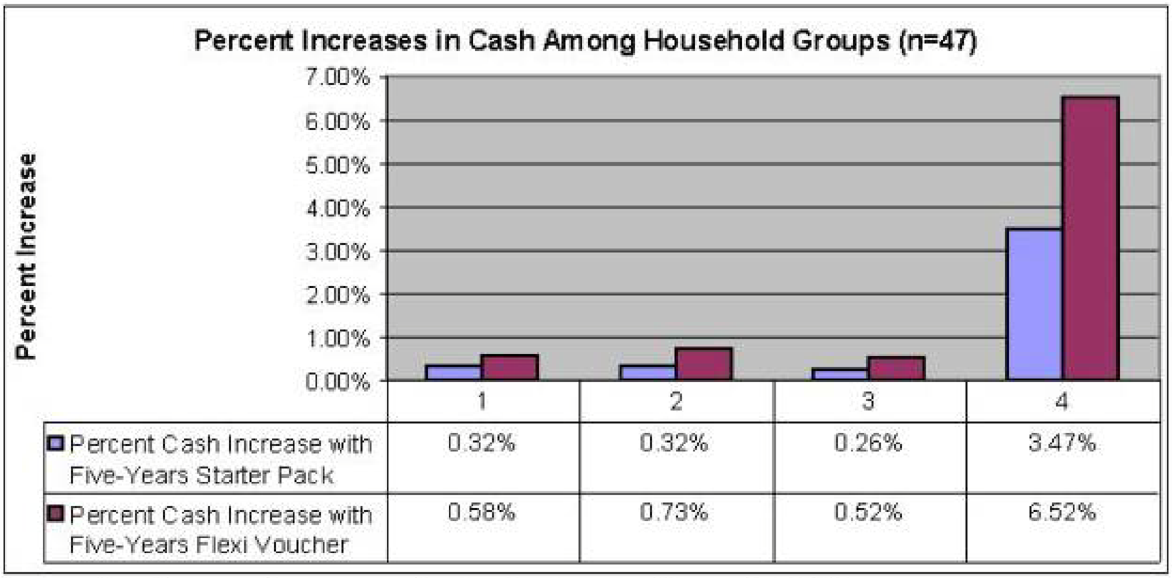


Figure 4: Percent Increases in Cash Among Household Groups

Change in Total Maize Production After Input Distribution

The potential of the starter pack program as an effective formal safety net, however, may not be reflected in its ability to increase household disposable cash income, but rather in its ability to improve household food production, both during the time period of free inputs and in subsequent years. To determine this potential, we examine the increases in household maize production over the seven-year time period, and then aggregate household maize production over the 47 households to get an estimate of aggregate maize production (for these 47 households). To compare pre- and post- starter pack maize production, a six-year analysis is compiled from a combination of scenarios 5-7 described above. The first year represents results from the linear program model without starter pack inputs, while years two through six represent results when starter pack inputs are included as activities of the linear program.

Graphs of aggregate maize production of the forty-seven households in figures 5-7 indicate that the greatest total maize production occurs when households receive starter pack inputs (figure 5), and the smallest total maize production occurs when households receive flexi vouchers (figure 7). This increase in maize production reflects increases in hybrid, not local, maize production.

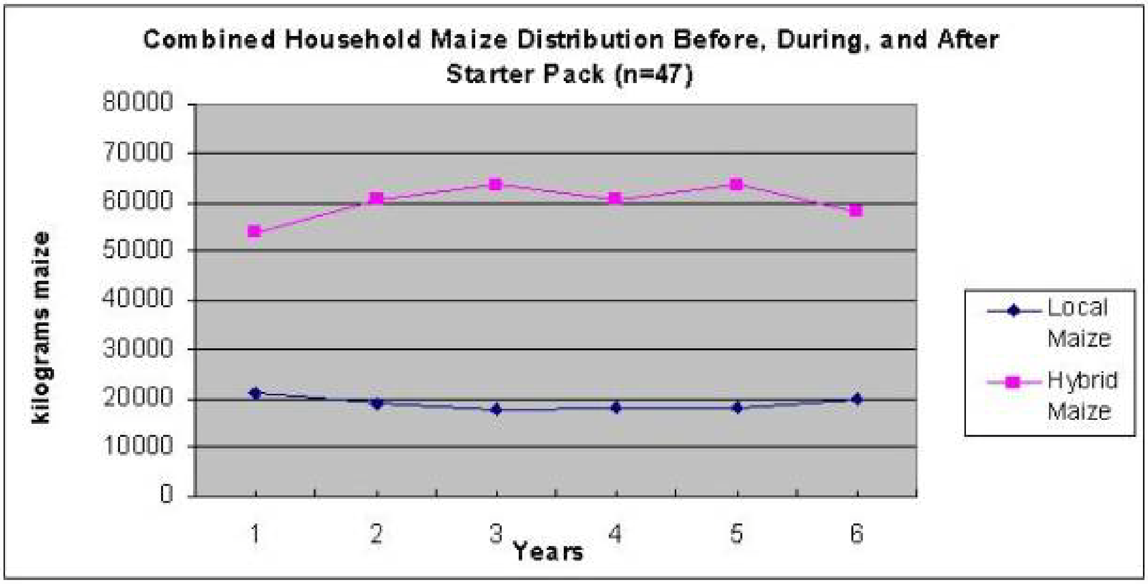


Figure 5: Combined Household Maize Distribution Before, During, and After Starter Pack (n=47)

With households receiving starter pack vouchers (figure 6), maize production does not increase in the first two years due to the predictions that households sell the vouchers for immediate cash. In later years, where predictions indicate that voucher recipients redeem vouchers for starter packs, an increase in maize production is evident. The increase, however, is less than that achieved when households receive an assembled starter pack for the five-year period (figure 5).

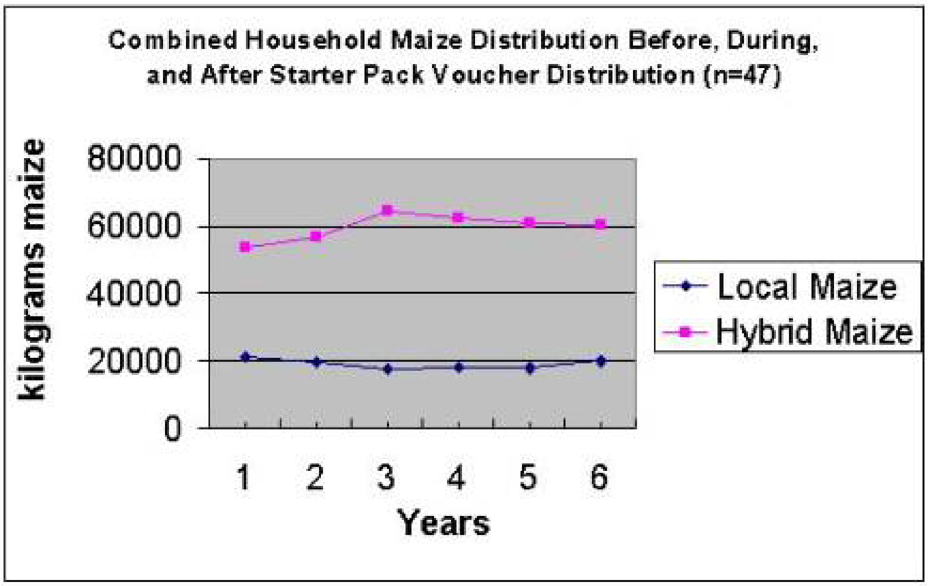


Figure 6: Combined Household Maize Distribution Before, During, and After Starter Pack Voucher Distribution (n=47)

With households receiving flexi vouchers (figure 7), the model predicts many households redeem the voucher for household goods available at retail outlets. Because the model predicts these goods are comprised of non-agricultural inputs, maize production increases minimally in this case.

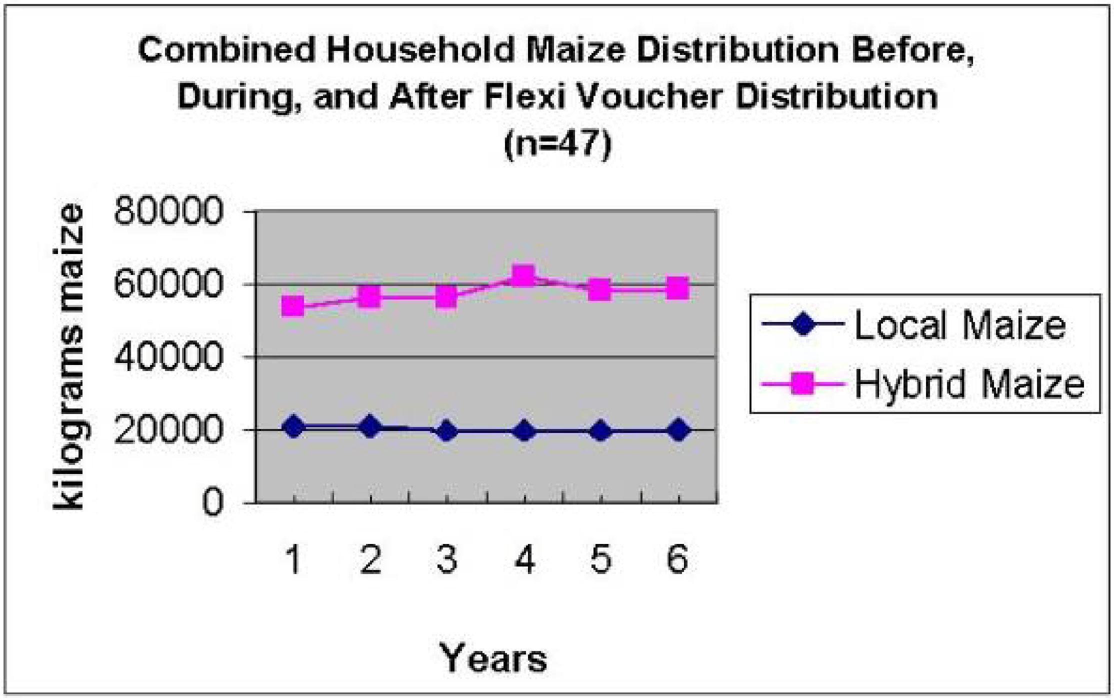


Figure 7: Combined Household Maize Distribution Before, During, and After Flexi Voucher (n=47)

DRAWING CONCLUSIONS OF THE STARTER PACK: DEFINING APPROPRIATE INPUTS

The purpose of this paper was to evaluate a test conducted by the government of Malawi in 1999/00 to distribute free inputs to smallholder farmers. With a sub-sample of selected farmers, government tested the efficacy of distributing vouchers versus assembled starter packs, to see whether the vouchers received by some of the farmers were more effective than the assembled packs received by other farmers. Using ethnographic linear programming models simulating the livelihood systems of 47 Malawi households, we examined the differential impact of the three distribution systems -- the starter pack, starter pack voucher, and flexi voucher, in order to determine which was the more effective tool for improving food security among Malawian smallholder farmers.

Results showed the most economically enhancing tool for smallholders, especially the poorest in group-four, were flexi vouchers. The benefit of distributing flexi vouchers was manifested through increased household cash income (averaging MK 2143 in group-four) and not maize production. We concluded this MK 2143 would purchase 450 kg of maize over the five-year period, enough to feed a chronically food-insecure family (with food requirements of 700 kg of maize per year) for 7.7 months spread over the five-year time period, or 1.54 months per year. [30] Unfortunately, this additional maize is probably not enough to make a chronically food-insecure household in Malawi food-secure. It is just too little in the Malawi situation where food-insecure households now face hunger seasons of five to six months.

This discretionary cash increase is less than the value of the vouchers, MK 2250, because of the labor or cash necessary to redeem the voucher. Further, it is unlikely that households would use all the additional cash for purchasing maize for consumption. Because of the strong desire among smallholders to produce their own maize, many households would invest in agricultural inputs and some would purchase household items. If this were the case, many households might not reach the highest potential increase in discretionary cash income.

We also tried to determine if the impacts depended on particular household characteristics, including gender and marital status of the household head. We concluded that because the majority of sample female-headed households were in the poorest group-four (figure 1), they would benefit relatively more than male-headed households from receipt of starter packs or flexi vouchers.

In scenario 5 with five years of starter packs, the average discretionary cash increase for group-four was only MK 868. Again, if the increased discretionary cash income were used solely for purchasing maize for consumption, a household would be able to purchase three and a half bags of maize. This 175-kilogram increase, however, represents only thirty-eight percent of the potential increase (450-kilograms) from flexi vouchers. Yet households increased maize production more after receiving starter packs and not flexi vouchers. Adding the 200 kilogram increase in maize production exhibited by these households, the potential maize increase of households after starter pack inputs becomes roughly 375 kilograms – still less than that occurring with flexi vouchers.

RECOMMENDATIONS

The actual cash or maize production increase that households experienced after receiving five-years of starter pack or vouchers was less than 8% in all cases. Yet even a minimal increase could constitute a significant degree of improved food security for the poorest households. The starter pack program, however, may not be the most effective mechanism of providing smallholders with a safety net. If a variation of the starter pack program is to be continued as a mechanism for improving food security for the poorest of the poor in Malawi, suggestions for defining appropriate inputs include:

a) Distribution of flexi vouchers or a similar tool allowing for household selection of goods;

b) Enhanced cooperation from retail outlets in order to increase smallholders' access to inorganic fertilizer;

c) Utilization of local retail outlet goods for distribution instead of distribution of prepackaged inputs in order to increase availability of desired goods (e.g., fertilizer) at retail outlets.

In conclusion, the starter pack distribution increased household discretionary cash and maize production minimally. Most households exhibited minimal increases in discretionary cash or total maize production after receiving inputs for even a five-year duration. Considering the massive cost of the program and the extensive amounts of planning, labor, and cooperation required, we recommend reducing the target population to group-four (and group-three if funds are available) and distributing inputs in a manner similar to that of flexi vouchers. Providing the option to obtain either agricultural inputs or goods with immediate cash value allows for the greatest potential increase in household cash income. Assigning inputs appropriate to the needs of the targeted households can potentially reduce misuse of inputs (i.e. selling or trading) and simplify the input distribution. While these changes might result in minimal improvements in food security, they do represent the comparatively greatest increase available from starter pack inputs included in the 1999/2000 distribution. Utilization of flexi vouchers holds potential benefit as a productivity-enhancing tool if redemption procedures allow smallholders – culturally, economically, and in a timely manner – access to those resources deemed beneficial to improving food security.

Notes

1. Sahn & Arulpragasam, 1991; Gladwin et al. 2001; Uttaro in this special edition.
2. Malawi's Ministry of Agriculture and Irrigation (MoAI), July 2000.
3. Lele 1999; Gladwin et al., 2001.
4. Lele 1999; Gladwin et al. 1997; Gladwin et al. 2001.
5. Food and Agricultural Organization (FAO).
6. Thomson and Metz, 1997.
7. Kumwenda et al. 1996.
8. Devereux 1999.
9. Kumwenda et al. 1996.
10. Gladwin 1991, 1992.
11. ibid
12. Sahn & Arulpragasam, 1991.
13. Benson 1997.
14. Benson, 1999.
15. Smale 1995.
16. Mann, 1998; Devereux 1999; Gladwin et al. 1999.
17. Mann, 1998.
18. Clark, 2000. page ii.
19. Longley et al. 1999. During the time of voucher redemption, MK 450.00 was equivalent to approximately US $ 9.00.
20. Killick, 2000. page 1-2.
21. Devereux, 1999; Gladwin et al. 1999; Gladwin et al. 2001.
22. Either because the smallholder population in Malawi is perhaps greater than 2.86 million, or because some households received more than one input package, a number of households received no starter pack inputs although they were eligible for input receipt.
23. Hildebrand et al. 2002.
24. Hildebrand & Poey 1985.
25. Benson 1999.
26. Hiebsch, 2000.
27. Ranhotra, 1985; from Penderson, 1989.

28. Conway and Chambers 1992; Scoones 1998.
29. Minimal differences between starter pack and starter pack voucher annual discretionary cash averages were due specifically to differences in labor requirements for traveling to redeem vouchers. In many cases, vouchers required more time due to the need to both obtain the voucher and travel to the retail outlet to redeem the voucher. However, the organization of local distributors and transport equipment created much variation in the amount of time required to obtain goods through any method of distribution.
30. Gladwin et al. 2001: Table 1, p. 182.

References

Benson, T. "The 1995/96 Fertilizer Verification Trial - Malawi." Report by Action Group I, Maize Productivity Task Force, Ministry of Agriculture and Livestock Development, Government of Malawi, Lilongwe, Malawi, 1997.

Benson, T. "Area Specific Fertilizer Recommendations for Hybrid Maize Grown by Malawian Smallholders: A Manual for Agricultural Extension Personnel." Report by Action Group I, Maize Productivity Task Force. Lilongwe, Malawi: Author, 1999.

Chambers, R., Conway, G. "Sustainable Rural Livelihoods: Practical Concepts for the Twenty-First Century." IDS Discussion Paper 296, Brighton: Institute for Development Studies, University of Sussex, 1992.

Clark, C. "Final Report: Implementation of Starter Pack Scheme." Malawi Starter Pack Logistic Unit: Author, February, 1999, page ii.

Devereux, S. "Making Less Last Longer." IDS Discussion Paper 373. Brighton, UK: Institute of Development Studies, University of Sussex, 1999.

Food and Agriculture Organization [FAO]. "Women Feed the World." Prepared for World Food Day, October 16, 1998. Rome: FAO Available: www.FAO.org December 15, 2001.

Gladwin, C.H. "Fertilizer Subsidy Removal Programs and Their Potential Impacts on Women Farmers in Malawi and Cameroon," In: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers. Gainesville, FL: University of Florida Press, pp. 191-216, 1991.

Gladwin, C.H. "Gendered Impacts of Fertilizer Subsidy Removal Programs in Malawi and Cameroon." Agricultural Economics 7 (1992): 141-153.

Gladwin, C.H., Buhr, K., Goldman, A., Hiebsch, C., Hildebrand, P., Kidder, G., Langham, M., Lee, D., Nkedi-Kiza, P., Williams, D. "Gender and Soil Fertility in Africa." Replenishing Soil Fertility in Africa, R. Vuresh and P. Sanchez, eds. SSSA Special Publication 51. Madison, WI: Soil science society of America (SSSA), 1997.

Gladwin, C.H., Thomson, A.M., Peterson, J.S., Anderson, A.S. "Addressing Food Security in Africa via Multiple Livelihood Strategies of Women Farmers." Food Policy 26 (2001): 177-207.

Gladwin, C.H., Uttaro, R. & Anderson, A.S. "Adaptive Strategies in Malawi." University of Florida: Author, 1999.

Hiebsch, C. "Furnishing Essential Diets (FED)." Unpublished database of: Energy and Protein Requirements: Report of a joint FAO/WHO/UNO expert consultation. WHO Technical Report Series 724. Geneva: Author, 2000.

Hildebrand, P.E. "Ethnographic Linear Programming." Gainesville, FL: Author, 2002.

Hildebrand, P. & Poey, F. On-farm Agronomic Trials in Farming Systems Research and Extension. Boulder, CO: Lynne Rienner Publishers Inc., 1985.

Hildebrand, P. & Waugh, R. "Farming Systems Research and Development." In P.E. Hildebrand (ed.), Perspectives on farming systems research and extension. Boulder, CO: Lynne Reinner Publishers Inc., 1986.

Killick, P. "Malawi Government Starter Pack Scheme 1999: Report on the Pilot Voucher Scheme." Starter Pack Logistics Unit. Malawi: Author, 2000, page 1-2.

Kumwenda, J.D.T., Waddington, S.R., Snapp, S. S., Jones, R.B., Blackie, M.J. "Soil Fertility Management Research for the Maize Cropping Systems of Smallholders in Southern Africa: A Review. Natural Resources Group Paper 96-2. Mexico City, Mexico: Centro Internacional para la Mejoramiento de Maiz Y Trigo, 1996.

Lele, U. "Structural Adjustment, Agricultural Development and the Poor: Some Lessons from the Malawian Experience. World Development 18 (1990): 1207-1219.

Lele, U., Christiansen, R.E., Kadiresan, K. "Fertilizer Policy in Africa: Lessons from Development Programs and Adjustment Lending, 1970-87." Managing Agricultural Development in Africa discussion paper 5. Washington, D.C.: World Bank, 1989.

Longley, C., Coulter, J., Thompson, R. "Malawi Rural Livelihoods Starter Pack Scheme, 1998-99: Evaluation Report." London: Overseas Development Institute, 1999.

Mann, C. "Higher Yields for All Smallholders; the Surest Way to Restart Economic Growth in Malawi." Cambridge, MA: Harvard Institute for International Development, 1998.

Ranhotra, 1985, from Penderson, B., Knudsen, K., & Eggum, B. "Nutritional Value of Cereal Products with Emphasis on the Effect of Milling." In G. Bourne (ed), World review of nutrition and dietetics, V 60: Nutritional value of cereal products, beans and starches. St George's University School of Medicine, Grenada, West Indies: Karger, 1989, pp 22-37.

Sahn, D., & Arulpragasam, J. "The Stagnation of Smallholder Agriculture in Malawi: A Decade of Structural Adjustment Period." Food policy, June, 1991 16(3), June: Author.

Scoones, I. "Sustainable Rural Livelihoods: A Framework for Analysis." IDS Discussion Paper 72. Brighton, UK: Institute of Development Studies, University of Sussex, 1999.

Smale, M. "Maize is Life: Malawi's Delayed Green Revolution." World Development 23 (1995): 819-831.

Thomson & Metz, (1997). Implications of economic policy for food security. A training manual. Rome: Food and Agriculture Organization of the United Nations.

Reference Style: The following is the suggested format for referencing this article: Gough, Amy E. , Christina H. Gladwin, and Peter E. Hildebrand. "Vouchers Versus Grants of Inputs: Evidence From Malawi's Starter Pack Program." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a8.htm

African Studies Quarterly | Volume 6, Issues 1 & 2 | Spring 2002

Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi

ROBERT. A. GILBERT, WEBSTER D. SAKALA AND TODD.D. BENSON

Abstract: The majority of farmers in sub-Saharan Africa are female, yet women often have limited access to extension information and agricultural inputs. Designing improved agricultural research and extension services for women in Africa is a challenging task since female farmers defy simple characterizations, and the effect of gender versus income levels relative to quality of extension services received is difficult to disentangle. The accurate characterization of farmers targeted by extension on a large scale supports efforts to quantify potential impacts of extension programs in Africa. A nationwide trial comparing legume cropping systems to fertilized and unfertilized maize controls was implemented at approximately 1400 on-farm sites by the Malawian extension service and cooperator farmers in the 1998-99 cropping season. In addition to agronomic yield data collection, extension agents conducted a socioeconomic survey of the farmers involved in the trial. The objective of the survey was twofold: to determine socioeconomic characteristics of the farmers collaborating with the extension service, and to assess farmer opinions regarding the cropping systems being promoted. Of the 1385 sites, only 270 (19 percent) involved female farmer cooperators, although women constitute 69 percent of the full-time farmer population in Malawi. The 1115 male farmers had significantly greater experience as head of household, used more fertilizer, and devoted a greater area to cash crops. There were no significant gender differences across crop yields when inputs were supplied, indicating that female farmers were as productive as their male counterparts. Farmer ranking and rating of the cropping systems were remarkably similar between the genders. *Mucuna pruriens* was perceived as having the lowest overall labor requirements, while fertilized maize had the highest food production rating. Unfertilized maize and local control plots fared poorly in both farmer rating and ranking of treatments. Overall, these results suggest that the extension service skewed the trials toward "well-to-do" male farmers. However, the extension service

Robert A. Gilbert is an Assistant Professor with the Agronomy Department at the University of Florida. From 1996-2000 he was a research fellow in Malawi, conducting work on improving soil fertility in the smallholder sector using legumes in maize-based cropping systems with the Department of Agricultural Research and Technical Services. His current research focus is sugarcane agronomy and breeding. **Webster D. Sakala** is the theme leader of integrated soil water and nutrient management for the soil fertility network for maize-based cropping systems which includes Malawi, Zimbabwe, Zambia, and Mozambique. He is also the team leader for maize research in Malawi. Currently his research is aimed at improving utilization and maximization of organic fertilizers for improving soil fertility for the resource poor farmers in Malawi. Part of this work is done in collaboration with Tropical Soil Biology and Fertility and The Royal Danish College of Agriculture. **Todd D. Benson** is a research fellow with the Food Consumption & Nutrition Division at the International Food Policy Research Institute in Washington, D.C., USA. A geographer, he lived in Malawi between 1994 and 2001, conducting socio-economic research with the Poverty Monitoring System and the Department of Agricultural Research and Technical Services.

http://www.africa.ufl.edu/asq/v6/v6i1-2a9.pdf

ISSN: 2152-2448

was able to implement a complex trial that included field days attended by over 106,000 farmers. Thus the national extension service in Malawi may well be suited to collaborate with and "scale-up" locally significant NGO efforts which may target more representative farmers.

Introduction

There has been increasing concern that female farmers in Africa are not receiving their fair share of extension advice. Doss, in a review of 25 years of literature on designing agricultural technologies for African farmers, found that female farmers, especially female-headed households, are often not contacted by extension services.[1] This view is corroborated by other literature which states that agricultural extension services are biased towards male farmers.[2]

However, Bindlish and Evenson, in a review of the training and visit (T&V) extension system in Kenya, concluded that the proportion of male- and female-headed households receiving extension advice was similar.[3] The majority of farmers found the T&V system useful, and the authors estimated the system provided a minimum of 160 percent return on investment. Doss notes that technology adoption and impacts are complex processes that defy simple characterization.[4] Doss and Morris found the gender variable not significant in explaining maize technology adoption in Ghana.[5] While the literature often states that cash and export crops are male crops while subsistence crops are cultivated by women, the lines of distinction are often blurred.[6] This is particularly the case with maize in Malawi, since maize is grown both for home consumption and market sale. The introduction of semi-flint hybrids with improved consumption characteristics such as MH17 and MH18 has greatly improved smallholder adoption of hybrid maize in Malawi.[7]

Malawi is only 118,000 km^2 in area, yet it has a very diverse agroecology, with 55 natural regions.[8] The elevation in agricultural areas varies from 0 to 2000 masl, with average annual precipitation ranging from 600 to 2000 mm . The varied terrain and soil type in hilly areas make it impractical to formulate uniform soil fertility recommendations. Recognizing these limitations, recent research and extension efforts have focused on the use of GIS systems to generate area-specific recommendations for fertilizer application and organic matter technologies. The precipitation pattern is unimodal, with 4 to 6 months of rain followed by 6 to 8 months of drought. High variability of precipitation both within and between growing seasons is typical of southern Africa and makes rainfed agriculture risky. The long drought period also makes double- or relay-cropping of legumes with maize problematic, as dry season growth and survival is poor for most species.

Like many African countries, Malawi's burgeoning population (Malawi's overall population density is 93 people km^{-2}) has led to decreased fallow periods, stagnant food production and declining food production per capita. However, Malawi is unique in its dependence on maize as its staple food crop. Over 90 percent of the total cultivated land area in Malawi is planted to maize, mostly by resource-poor smallholders. Malawians consume over 150 kg maize yr^{-1}, (which constitutes greater than two-thirds of their caloric consumption), the largest per capita consumption of maize in the world.[9] There is evidence of declining soil organic matter as soils are continuously cropped to maize. Mean organic carbon in three regions has declined 10 to 31 percent over a 20 year period.[10] Devaluation of the Malawi Kwacha and the elimination of fertilizer and maize price subsidies have contributed to a rising fertilizer to maize price ratio. These trends have consequently made it economically unattractive to use fertilizer for the production of maize for market sale.[11]

The unprofitability of inorganic fertilizers has encouraged agricultural researchers to assess the potential of legumes grown in association with maize, or in rotations with maize. However, the success of any given system varies with local agroecology. For example, groundnut is generally planted in hotter, drier, low-medium altitude areas (< 1000 m) near Lake Malawi, while *Phaseolus* beans are usually grown in the cool humid highlands. Livestock density tends to be greater in northern Malawi where human population densities are lower. Livestock are allowed to graze freely in the dry season in northern Malawi (they are tied throughout the year in southern Malawi), and can cause extensive damage to legumes such as pigeonpea which remain green during the dry season. This factor alone serves as a strong disincentive for the adoption of long-duration legumes in northern Malawi.

The socioeconomic and biophysical context of Malawi has important implications for legume cropping systems. Farmers are searching for ways to ameliorate soil fertility that reduce the need for inorganic fertilizers. This provides an opportunity for inclusion of legumes. However, because land pressure is intense any proposed leguminous system must be competitive with continuous maize on the basis of calorie production per hectare and economic net benefits.

Household food security is particularly important in Malawi, given the low average level of income. In a comprehensive poverty study of Malawi, 66 percent of rural Malawians were defined as poor (falling below a poverty line of $0.26 to $0.85/day, depending on region).[12] Survey results showed that 25 percent of households surveyed were headed by women. The average area farmed per household in Malawi was 0.99 ha nationwide, but only 0.76 ha in the more densely-populated southern region. More than half of all the calories consumed in rural households were derived from the fields they farmed. Seventy-two percent of all rural households cultivated maize, with a median hybrid maize yield of 850 kg ha^{-1}. Fifty-three percent of these households used at least some fertilizer. Nineteen percent of these households cultivated tobacco, the main cash crop.

Smale et al. conducted a longitudinal survey of 349 households in 3 (out of 8) Agricultural Development Divisions in Malawi.[13] The proportion of farmers using inorganic fertilizer on maize ranged from 45 to 65 percent from 1990 to 1997. Farmers growing tobacco had significantly higher use of fertilizer on maize. "Well-to-do" households were classified by farmers as those that had maize stocks that lasted from year to year, owned livestock or oxcarts, or possessed several changes of clothing.

Due and Gladwin reported a survey of male- and female-headed households from two districts in central Malawi.[14] Male-headed households used significantly higher amounts of fertilizer than female headed households (72 vs. 30 kg), had higher intensity of fertilizer use (51 vs. 34 kg ha^{-1}), and larger average landholding size (1.33 vs. 0.80 ha). The authors maintain that institutional barriers and social constraints have limited the participation of female farmers in farmers clubs and reduced their access to credit, which collectively constrains their levels of fertilizer use. When farmers' access to cash and credit and land are taken into account, the gender variable has no significant effect on fertilizer use. This implies that it is the lack of access to resources rather than lack of managerial abilities that limit women's use of fertilizer in Malawi.

This paper reports results from a legume cropping system trial and survey implemented by the Malawian extension service during the 1998-99 cropping season. This trial was successfully implemented by 1385 extension agents representing every Agricultural Development Division and natural region in Malawi. It should be noted that the farmer cooperators were not chosen at random, having been selected by the extension service. The objective of this exercise was to determine the socioeconomic characteristics of the farmers the extension service was working with, what these farmers thought of the cropping systems being promoted, and how these crops yielded under their own management on their farms. The results are disaggregated by gender and agroecological zone in this analysis.

MATERIALS AND METHODS

The farmer survey and cropping system trials were implemented by extension agents trained by Action Group I of the Maize Productivity Task Force (MPTF) in Malawi. The MPTF was established in 1995 by the Ministry of Agriculture and Irrigation (MoAI) to increase productivity of maize-based cropping systems.[15] It was funded by the World Bank, the European Union and The Rockefeller Foundation, and divided into four Action Groups. Action Group I was responsible for research and extension on inorganic fertilizer and integrated nutrient management. The group had recently completed a nationwide verification trial on area-specific fertilizer rates on maize.[16]

The MPTF had the mandate to coordinate research and extension efforts among MoAI, international research centers, non-governmental organizations (NGOs), industry and the donor community. Research and extension efforts on legume cropping systems have been carried out by Action Groups I, II and IV. While there are numerous local efforts at diffusion of legumes through various NGOs, the MPTF provided an institutional context of research and diffusion at a national scale.

All extension agents in Malawi were trained and provided inputs for this trial. The agronomic trial consisted of 6 treatments, listed in table 1 below.

Table 1. Six treatments used in the cropping system trial conducted during the 1998/99 growing season.

ID†	System	Description
GL	Grain legume rotation	Either Magoye soybean (Glycine max) or CG7 groundnut (Arachis hypogaea)
MP	*Mucuna pruriens* (kalongonda) rotation	*Mucuna pruriens* (velvetbean)
MZ/PP	Maize/pigeonpea intercrop	Maize and ICP 9145 pigeonpea (*Cajanus cajan*) intercropped together on the same plot
MZ+F	Fertilized maize	Hybrid maize fertilized at either 35:10:0+2S or

		69:21:0+4S ($N:P_2O_5:K_20+S$)
MZ	Unfertilized maize	Hybrid maize seed without fertilizer
Local	Local control	No treatment imposed; maize yield data collected from farmer's own field adjacent to research plots
†This ID is used in Figure 2 A-F.		

The grain legume (GL) rotation, *Mucuna pruriens* (MP) rotation and maize/pigeonpea (MZ/PP) intercrop were selected as promising candidates for evaluation since these legume cropping systems have demonstrated consistently higher calorie production, economic net benefits and soil fertility improvement than unfertilized maize.[17] The fertilized maize treatment (MZ+F) was included at rates of 69:21:0 + 4S ($N:P_2O_5:K_20$ + S) or 35:10:0 + 2S according to recent work on area-specific fertilizer rates in Malawi.[18] Two controls were included in this trial. The continuous unfertilized maize (MZ) treatment consisted of unfertilized hybrid maize (MH17 or MH18, depending on agroecology of the trial site). The local control plot (Local) served as a local farmer practice control. It was simply a cropped area on the farmer's own field adjacent to the research plots, from which farmer-produced maize yield data were gathered.

The two maize cultivars chosen for the MZ control are suitable for different agroecological zones in Malawi. MH17 matures in 140-150 days and is suitable for highland elevations > 1000 m. MH18 matures in 120-130 days and is recommended for low-medium altitude zones < 1000 m. Figure 1 shows the administrative regions in Malawi where these cultivars were distributed for this treatment, which corresponds to high vs. low-medium altitudes. In order to identify potential differences in recommendation domains in these zones, the data were segregated both by gender and maize cultivar used.

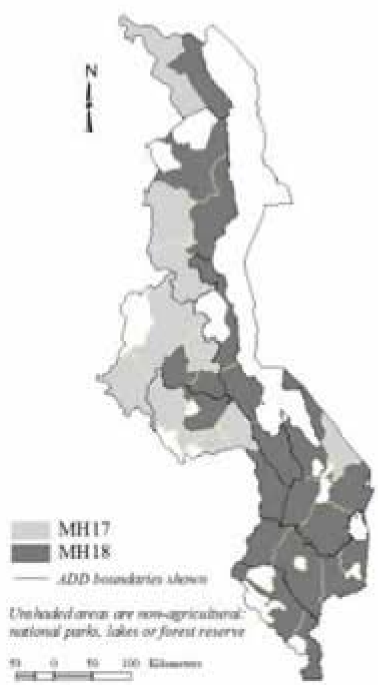


Figure 1. Map of agroecological zones in Malawi in which MH17 (high altitude) and MH18 (low-medium altitude) maize cultivars were used.

Trial inputs such as seed, fertilizer, and survey instructions were distributed to the extension agents during their training. These agents selected the farmers that implemented the trial. The trial was managed by these farmers, and survey and yield data were collected by the extension agents.

In addition to the agronomic trial, the extension service also conducted a socioeconomic survey with the farmers on whose land the trial was implemented. At the beginning of the growing season, farmers were interviewed to determine their cropping practices and resource levels. At the end of the growing season, these same farmers were asked to evaluate the cropping system treatments. The only incentive for farmers to participate in the study were the provision of free inputs and the crop harvest, there were no cash incentives involved.

RESULTS AND DISCUSSION

Table 2 below presents descriptive statistics, disaggregated by gender and agroecological zone, of the farmers involved in the trial. Extension agents chose to work with female farmers on only 19 percent of the Action Group I sites. Given that female farmers make up 69 percent of the total full-time farmers in Malawi, the 19 percent figure may indicate that extension agents, most of whom are male, chose a disproportionate percentage of male farmers to implement the demonstration.[19] This may be a further example of the male bias in extension that Staudt documented for Kenya. [20] However, Benson and Due and Gladwin state that 25 percent of farm households in Malawi are female-headed. [21] Extension agents may be choosing farmers on the criteria of land and labor resources to successfully implement the trial. These particular farmers would most likely be heads of households with above-normal resource levels, not necessarily a random sampling of representative farmers in the study. Female-headed households in Africa tend to be smaller in family size with smaller landholdings and lower levels of income. [22] It is difficult to separate the effect of gender vs. income on access to extension services. Doss and Morris found that larger landholdings, larger areas planted to maize and higher technology adoption rates are all correlated to gender, and that these factors may influence the quality and frequency of extension agent visits. [23]

T-tests applied to the survey data revealed a number of significantly different comparisons (Table 2). Relative to their female counterparts, male farmers had spent more time (years) as head of household in both agroecozones. Male households had a greater number of children in both zones as well. The total amount of fertilizer used in the previous year was significantly greater in the high-altitude zone, with male farmers having a greater intensity of use in both zones. Total field area, maize area in the high-altitude zone, tobacco area, and cotton area in the low-medium altitude zone (as expected, cotton was not grown by either gender at high elevations) were significantly greater for male farmers. Number of cattle, goats and chickens owned were significantly greater for men in both zones. Land area devoted to food crops such as sorghum, millet, cassava, groundnut, sorghum, pigeonpea and bean were not significantly different between genders.

The higher average land area, cash crop area and livestock units owned are all indicative of higher levels of household resources available to the male farmers in this study. These results are consistent with other surveys in Africa. [24] For example, Saito et al. found that African women have generally smaller landholdings, household sizes and lower incomes. [25] However, both male and female farmers were "well–to-do" by Malawian standards. [26] The small average farm size, especially in the south, makes implementation of large-scale demonstrations difficult. Each trial plot was 100 m^2 for a total land area of 600 m^2 devoted to this demonstration. Thus extension agents may have unwittingly selected a subset of farmers with land holdings large enough to accommodate the trial without disturbing the farmer's own cropping patterns.

Table 2. Descriptive data of Malawian farmers completing trial survey, disaggregated by gender and agroecological zone.

	High-altitude (MH 17) zone				Low-medium altitude (MH 18) zone			
	Female	Male	T stat	P level†	Female	Male	T-stat	P level†
N	92	404			178	711		
Age	44.0	44.5		NS	45.1	47.0	-1.77	‡
Adults in household	3.6	3.7		NS	3.7	3.7		NS
Children in household	2.6	3.2	-2.70	**	2.9	3.2	-1.67	‡
Years head of household	12.3	18.6	-3.42	***	11.4	19.4	-6.36	***
Urea amount used (kg)	25.9	44.2	-3.15	**	18.6	18.9		NS
23:21 ($N:P_2O_5$ fertilizer) amt. used (kg)	36.0	66.2	-3.68	***	20.4	28.9	-2.03	*
Field area (ha)	1.50	1.84	-3.11	**	1.18	1.57	-5.19	***
Maize area	0.84	0.97	-1.98	*	0.81	0.88		NS
Tobacco area	0.12	0.23	-4.64	***	0.04	0.10	-4.17	***
Cotton area	0.00	0.00		NS	0.04	0.12	-4.86	***
Sorghum area	0.01	0.01		NS	0.10	0.09		NS
Millet area	0.06	0.06		NS	0.02	0.04		NS
Cassava area	0.06	0.09		NS	0.13	0.13		NS

Groundnut area	0.22	0.25		NS	0.17	0.16		NS
Soybean area	0.12	0.10		NS	0.04	0.04		NS
Pigeonpea area	0.02	0.01		NS	0.20	0.18		NS
Mucuna area	0.02	0.00	2.33	*	0.04	0.03		NS
Bean area	0.27	0.22		NS	0.07	0.08		NS
Cowpea area	0.08	0.05		NS	0.07	0.13	-3.34	***
Chickens owned	7.3	8.7	-1.86	‡	7.8	9.3	-2.24	*
Goats owned	2.0	2.8	-2.04	*	2.3	2.8	-1.87	‡
Cattle owned	0.8	1.4	-2.09	*	0.2	1.0	-5.54	***

Women farmers were three times as likely as men to have had no formal education (Table 3), and had lower percentages than men of 1 to 4 or > 4 years of education in both zones. The percentage of men and women using fertilizer in the previous year was similar to that previously reported in the low-medium altitude zone, but higher for men in the high-altitude zone. [27] Men in this zone were also more likely to hire ganyu† labor than women, and they had the highest percentage of ox-cart ownership. Overall, the large land areas, level and intensity of fertilizer use of men in the high-altitude zone indicate that they had the greatest level of resources of the farmer groups analyzed in this study.

Table 3. Education and surrogate wealth measures disaggregated by gender and agroecological zone.

	High altitude (MH 17) zone				Low-medium altitude (MH 18) zone			
	Female		Male		Female		Male	
	Yes	No	Yes	No	Yes	No	Yes	No
	------------------- percent-------------------				------------------- percent-------------------			
Education level:								
None	36	--	11	--	26	--	10	--
1-4 years of school	18	--	24	--	27	--	33	--
> 4 years of school	46	--	65	--	47	--	57	--
Used fertilizer last year	60	40	74	26	51	49	52	48

Hired ganyu labor†	30	70	45	55	45	55	45	55
Worked as ganyu labor	31	69	30	70	27	73	26	74
Owns ox-cart	5	95	12	88	1	99	5	95
Owns bicycle	30	70	66	34	40	60	71	29
Eaten Mucuna	32	68	23	77	67	33	51	49

Men were twice as likely to own a bicycle as women in both zones (Table 3). A greater percentage of women than men reported having eaten *Mucuna* before in both zones. However, more than 2/3 of the women and ½ of the men had eaten *Mucuna* in the MH18 zone, which included the areas in southern Malawi where it is traditionally cultivated, compared to less than 1/3 of both genders in the MH17 zone. Prior experience with *Mucuna* is important as *Mucuna* must be prepared carefully before human consumption in order to eliminate the toxin L-Dopa from the seed. [28]

Table 4 shows the adjusted treatment yields for male and female farmers in the 1998-99 cropping season. The only significant difference between male and female farmers in either zone for the imposed treatments was the grain legume rotation in the high altitude zone. Thus when female farmers were provided the seed and fertilizer inputs for the trial, their farm management efforts were equally as productive as the male farmers. Significantly lower maize yields were measured in the women's local control plot in both zones. Roughly 39 percent of women applied fertilizer to this plot compared to 44 percent of the male farmers, and the female farmer's local control plots also recorded lower yields when fertilizer was not applied.

Table 4. Demonstration trial yields (kg ha^{-1}) in 1998/99 disaggregated by gender and agroecological zone

		High altitude (MH 17) zone				Low-medium altitude (MH 18) zone			
		Gender			T-Test	Gender			T-Test
Treatment		Female	Male	T-stat	P level†	Female	Male	T-stat	P level†
ID	System								
GL	Grain legume rotation	880	1040	-2.59	*	960	990		NS
MP	Mucuna rotation	1660	1710		NS	1580	1720		NS
MZ/PP	Maize/pigeonpea intercrop (pigeonpea)	230	280		NS	540	480		NS

MZ/PP	Maize/pigeonpea intercrop (maize)	1040	1070		NS	1260	1360		NS
MZ+F	Maize + fertilizer	2460	2470		NS	2540	2560		NS
MZ	Maize without fertilizer	960	1020		NS	1230	1280		NS
Local	Local control plot	990	1180	-2.01	*	1250	1400	-1.82	‡
† ‡,*,**,*** = significant at P<0.10, 0.05, 0.01, 0.001, respectively.									

Treatment yields with *Mucuna* exceeded those of the other legume grain yields (GL and MZ/PP), indicating more biomass production for soil fertility improvement. While the pigeonpea yields were low, the maize yield in association was not significantly reduced, thus more food was produced in the maize/pigeonpea intercrop compared to sole unfertilized maize. Pigeonpea yields were 50 percent lower in the high altitude zone. The fertilized maize plot, as expected, produced the greatest number of calories ha^{-1} during this trial.

The farmer ranking and rating of the different cropping systems were remarkably similar between genders (Figure 2 A-F).

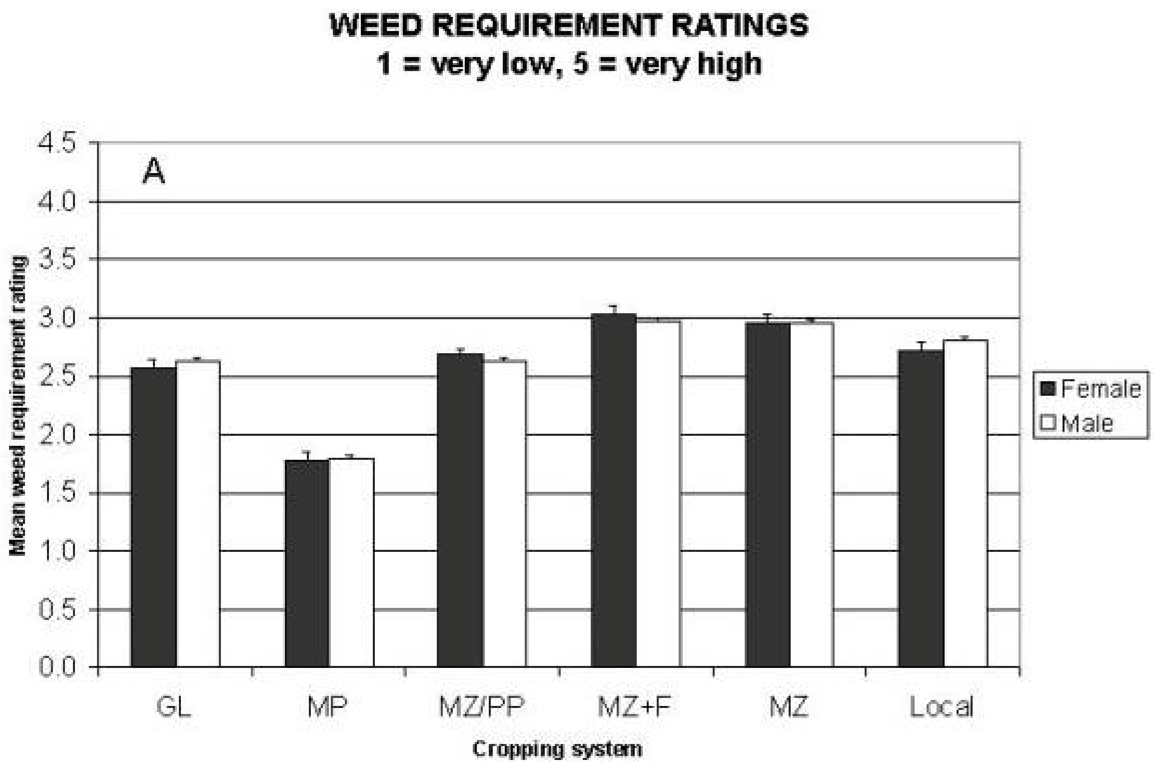


Figure 2 A (above): Weed requirement ratings of the 6 cropping system treatments

There were no significant differences between gender ratings in any of the treatments, nor were there significant differences between zones, thus the zones have been pooled in Figure 2. *Mucuna pruriens* had the lowest perceived weeding requirement (Fig. 2a). This is not surprising as *Mucuna* is internationally renowned for its ability to produce large amounts of biomass which shades out weeds. [29]

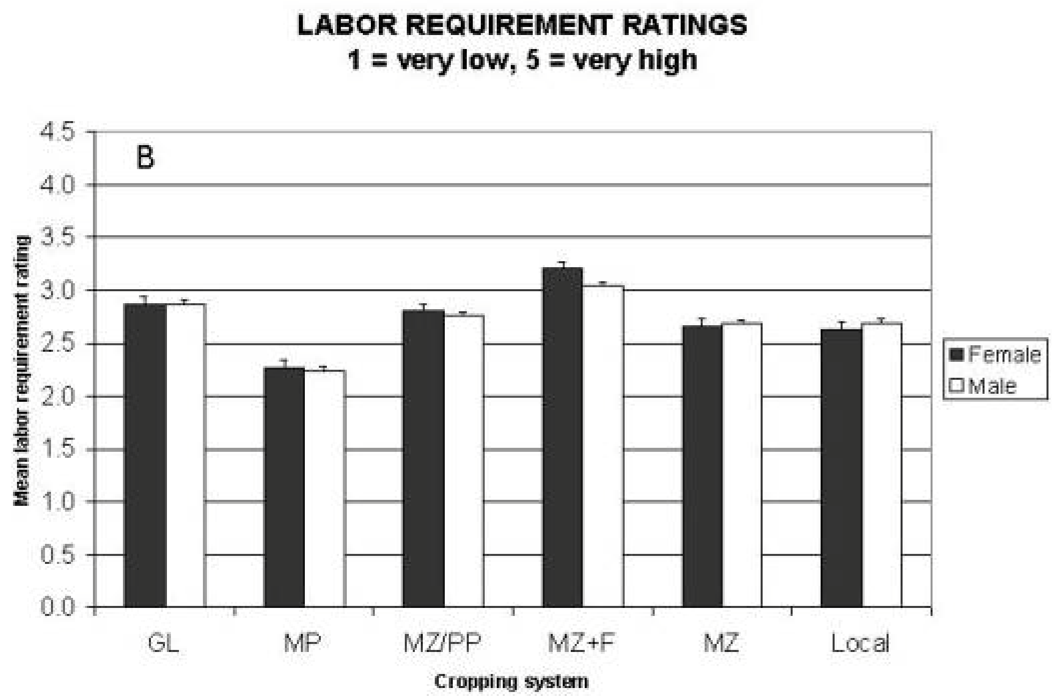


Figure 2 B (above): Labor requirement ratings of the 6 cropping system treatments

Mucuna also had the lowest overall labor requirement for the entire growth cycle as rated by the farmers in this study (Fig. 2b). Fertilized maize, which had the highest grain yields, received the highest rating for total food production (Fig. 2c). The unfertilized maize treatment and the local control were rated the poorest in this regard. These control treatments also fared poorly in the estimated profitability ratings (Fig 2d), in which the fertilized maize treatment rated the highest. It must be noted that the farmers were not asked to pay for the seed and fertilizer used in this study, so the ratings may be influenced by the free inputs provided in the trial, which were substantially more valuable for the inorganic fertilizer inputs than the organic alternatives. Estimated soil fertility improvement was highest for *Mucuna*, followed by the grain legume, maize intercropped with pigeonpea, then fertilized maize (Fig. 2e), with both control treatments receiving the lowest ratings.

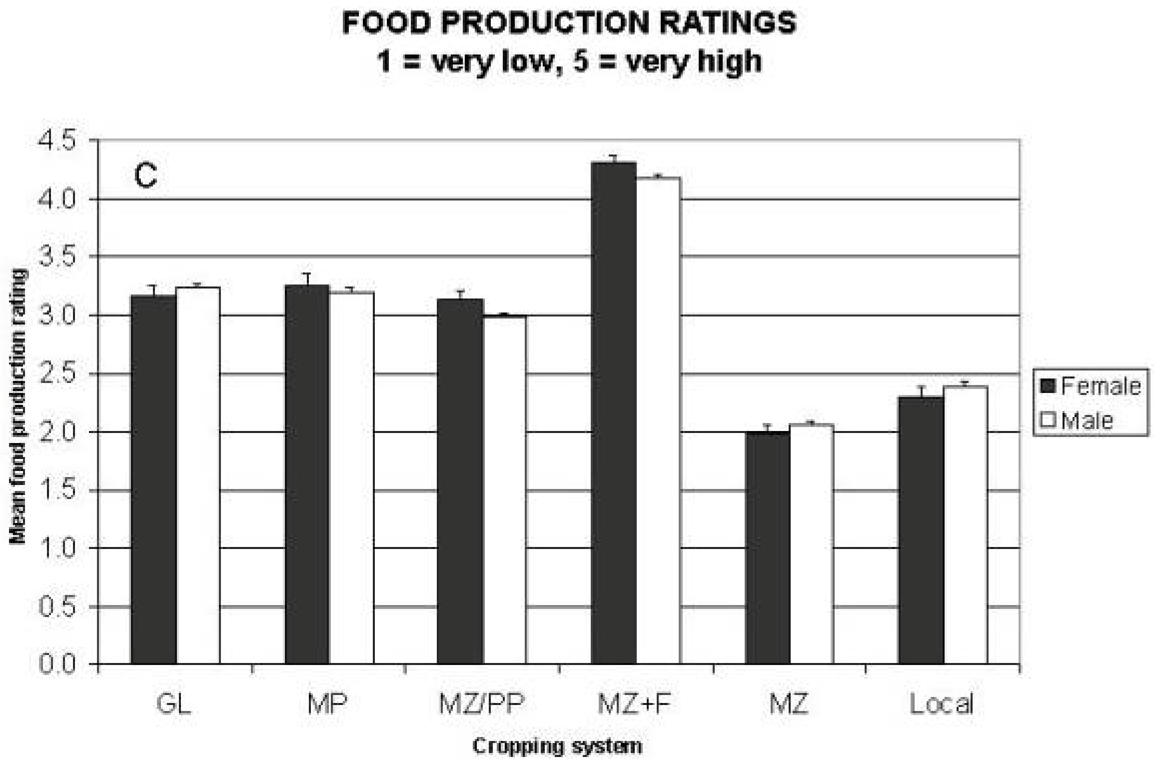


Figure 2 C (above): Food Production ratings of the 6 cropping system treatments

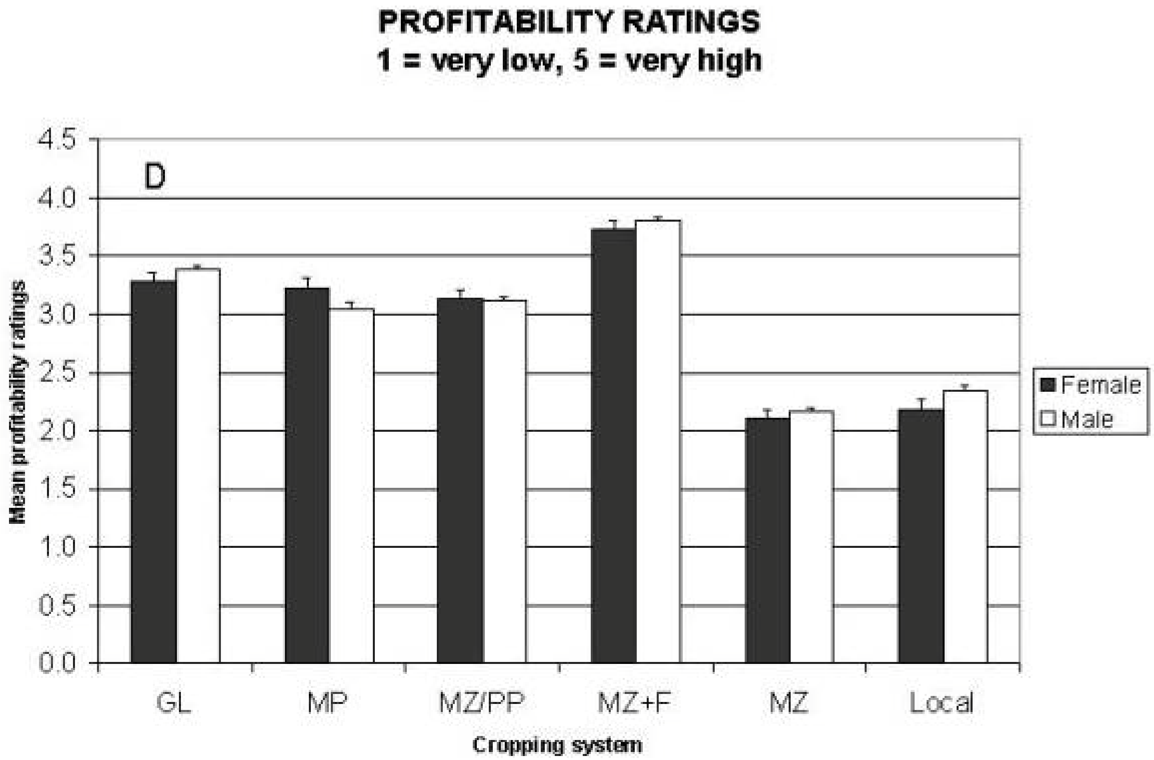


Figure 2 D (above): Farmer-estimated profitability of the 6 cropping system treatments

When asked to rank the crop production treatments from 1 (best) to 6 (worst), fertilized maize received the most favorable ranking, followed by the legume rotations and intercrops (Fig. 2f). Consistent with earlier rating criteria, the control treatments were least favorably regarded. The high ranking of the fertilized maize in relation to various legumes is not surprising as the farmers had yet to see the soil fertility benefits of the legumes to subsequent maize crops. In addition, farmers did not pay for the fertilizer used, which may have biased their rankings. We expect the ranking results to differ after farmers see the benefits of legumes in rotation after the conclusion of the trial, in which maize is planted after the legumes.

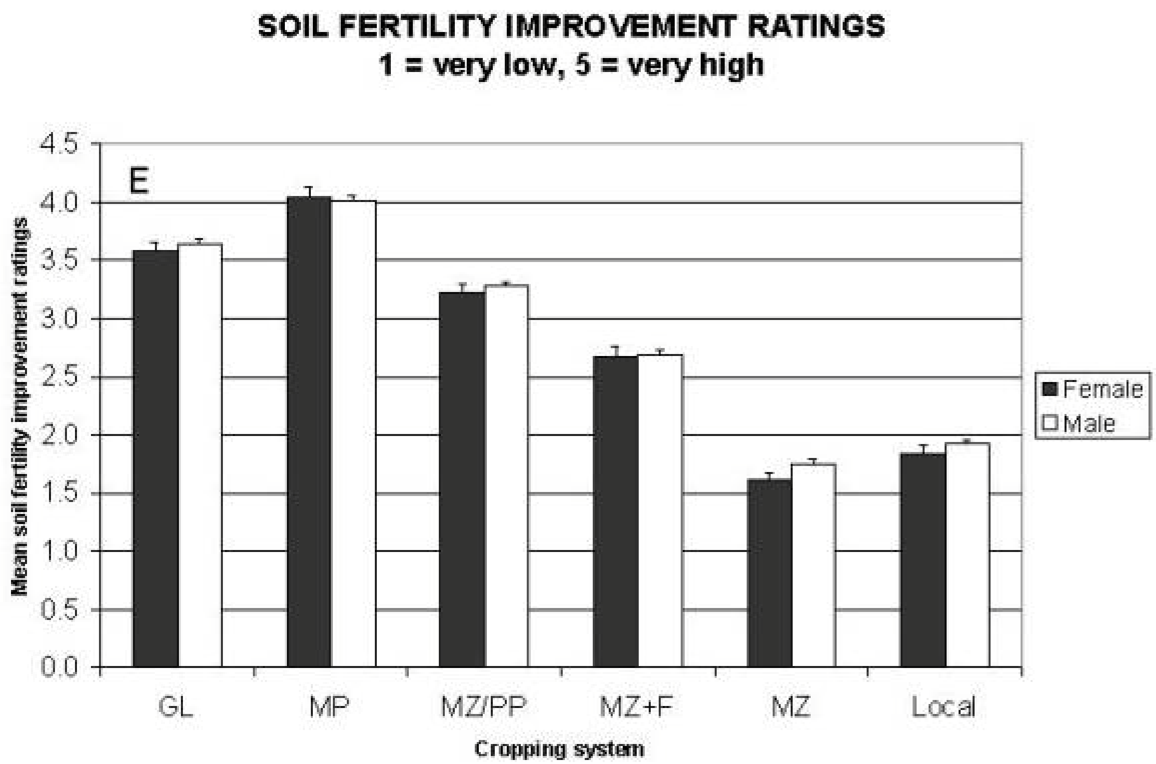


Figure 2 E (above): Farmer-estimated soil fertility ratings of the 6 cropping system treatments

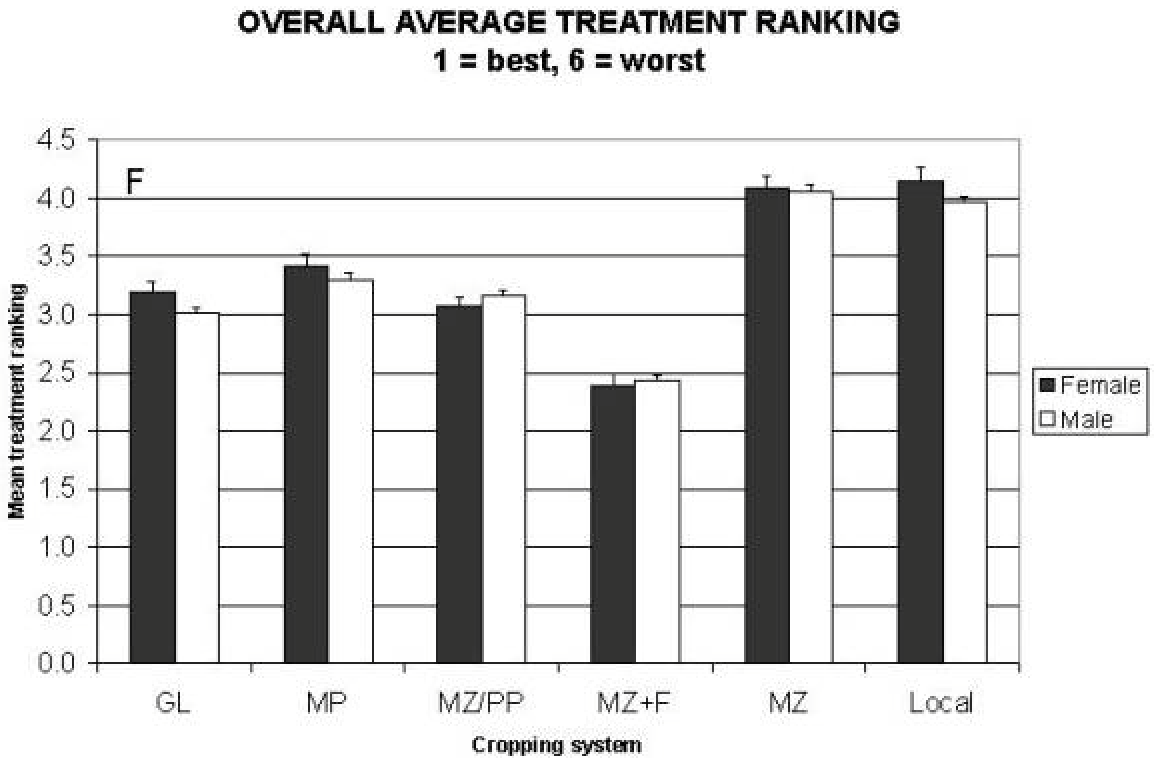


Figure 2 F (above): Overall ratings of the 6 cropping system treatments

The leguminous systems were all similarly ranked (no significant difference) between the fertilized maize and the control treatments. Each of these systems has tradeoffs associated with its use. For the grain legumes such as groundnut and soybean, there are well-established seed markets for these protein and oil-rich nutritious crops. However, seed storage and planting costs for groundnut tend to be high, and adoption levels of soybean have fluctuated dramatically with prevailing market prices. Also, leguminous residue incorporation for soil fertility benefit is limited with these crops as the residue is generally removed from the field when the crop is threshed at the household. Pigeonpea is advantageous in this regard, as the N-rich leaves fall off before the seed is threshed. Pigeonpea also has the advantage of not being competitive with maize, so maize can be produced in association with the legume. However, pigeonpea grain yields are generally lower than the other legumes (Table 4), and often produce no seed when browsed by goats in northern and central Malawi. *Mucuna* has consistently produced higher seed yields and biomass than other legumes grown in Malawi, however extreme caution must be taken in the preparation of the seed for human consumption (Table 4). Traditional Malawian recipes involve boiling the seed for 8 hours or more, which is clearly not economical, although new recipes with reduced boiling times are being promoted by the extension service. Clearly, no single leguminous system will be a panacea for all smallholders in

Malawi. However, the comprehensive nationwide assessment of cropping systems presented herein provides Malawian farmers with additional production options, and allows them to make informed choices regarding which system(s) may fit their needs.

Why was the local control practice ranked so poorly, yet still implemented by these farmers? There is often a large practical difference between what a farmer would like to do and what they are able to do given their level of resources. Usually farmers know how to produce higher crop yields, but are not able to afford the inputs or labor necessary to obtain them, especially in the case of women farmers, as shown in development literature. [30]

Conclusions

The Malawian extension service successfully implemented a complex agronomic trial and socioeconomic survey concurrently throughout Malawi. While current funding trends are toward smaller-scale NGOs working on a watershed scale, this study shows that the extension service has an important role to play in scaling-up the results of agronomic research. However, the farmers chosen to implement this trial were skewed towards better-off male farmers. Roughly 81 percent of the farmers chosen were male, and they had 1.7 times the average land-holdings in Malawi. The disproportionate representation of better-off male farmers may raise concerns about the trial results. That does not mean, however, that only these farmers were exposed to these technologies. A total of 106,000 farmers attended field days associated with these trial sites in 1998-99.

African farmers, both men and women, have stated that they want more field days. [31] Bindlish and Evenson, in a review of the T&V system in Kenya, found that field days were considered an effective way to deliver extension advice. [32] The majority of farmers, including 55 percent of the female-headed households, had attended a field day in their area. Seventy to seventy-five percent of all farmers had adopted practices such as improved plant spacing, timely planting and improved cultivars, but only 10-22 percent had adopted more complex and costly practices such as topdressing fertilizer or stalk borer control. Male and female farmers had dissimilar adoption rates for fertilizer (75 vs. 44 percent for basal dressing) suggesting that financial constraints characterizing female-headed households will tend to support reduced adoption rates, even when exposed to new technology. Thus exposure is most likely a necessary but not sufficient condition for adoption of new agricultural technologies. While many researchers advocate increasing the number of female extension agents to target female farmers, Berger et al. state that focusing on female farmers alone may be counterproductive regarding efforts to increase their agricultural productivity as these programs traditionally have focused on home economics issues. [33] They state that broad, general, non-crop specific programs at the Ministry of Agriculture level have the greatest potential for assisting women. Evidence from Evenson on the efficacy of the T&V extension system in Africa indicates that high levels of farmer exposure to new technologies and technological information is very useful, no matter how unrepresentative the targeted clientele might be. [34] In summary, the national extension service in Malawi is well suited to collaborate with and “scale-up” locally significant NGO efforts which may target more “representative” farmers.

Male heads of household had significantly higher fertilizer use, cash crop area and total field area than female farmers, indicating higher levels of land, labor and cash available to the male farmers. However, when trial inputs were provided, there were no significant differences in grain yield of maize or legumes between male and female farmers, indicating that the female farmers were equally productive. The female farmers did have significantly lower maize grain yields on their own field plots.

The rating and ranking of treatments was remarkably similar between genders. Both male and female farmers felt that *Mucuna pruriens* had the lowest labor requirements, while fertilized maize produced the greatest amount of food. Both the unfertilized hybrid maize and the local control plots fared poorly in the ratings and rankings. In the overall ranking, fertilized maize was ranked significantly better than the other treatments. This is to be expected as farmers had yet to see the benefits of legumes in rotation after one year of growth, and the rankings may have been influenced by the free inputs provided in the trial. A trial that more accurately reflects both the demographics of the target population and the farmers' bearing the true costs of the trial may generate different conclusions, particularly regarding preference for fertilized maize production systems.

Future plans for the trial include a second year of data collection on crop yields and farmer rankings to see if the benefits of legumes in rotation change farmer perceptions. In addition, an economic analysis of the 2-year trial will be conducted taking into account the seed and fertilizer costs associated with each treatment. The overall goal is to identify and evaluate a range of crop production strategies that will serve to reverse declining soil fertility trends documented on smallholder farms in Malawi.

Notes

† Ganyu is the common term for piece-work hired labor in Malawi, normally paid on a daily basis.

1. Doss, 2001
2. Due et al., 1997; Saito and Weidemann, 1990; Saito and Spurling, 1992; Saito et al., 1994; Berger et al., 1984
3. Bindlish and Evenson, 1993
4. Doss, 2001
5. Doss and Morris, 2001
6. Koopman, 1993; Kuwar, 1987
7. Smale and Heisey, 1997
8. Benson, 1997a
9. Smale and Heisey, 1997
10. Blackie et al., 1998
11. Benson, 1997b
12. Benson, 2000
13. Smale et al. (1998)
14. Due and Gladwin (1991)
15. Rukuni et al., (1998)

16. Benson (1997b)
17. Gilbert (1998)
18. Benson (1997b)
19. Due and Gladwin (1991)
20. Benson (2000); Due and Gladwin (1991)
21. Staudt (1975)
22. Doss (2001); Doss and Morris (2001); Saito et al., (1994)
23. Doss and Morris (2001)
24. Doss and Morris (2001); Doss (2001)
25. Saito et al. (1994)
26. Smale et al. (1998)
27. Smale et al. (1998)
28. Lorenzetti et al. (1998)
29. Buckles et al. (1998)
30. Quisumbing (1996)
31. Due et al. (1997)
32. Bindlish and Evenson (1993)
33. Berger et al. (1984)
34. Evenson (1992)

References

Benson, T.D. 1997a. Developing flexible fertilizer recommendations for smallholder maize production in Malawi. pp. 275-285. In: (Waddington et al., eds) Soil Fertility Research for Maize-Based Farming Systems in Malawi and Zimbabwe. SFNET/CIMMYT. Harare, Zimbabwe. 312 pp.

Benson, T.D. 1997b. The 1995-96 fertilizer verification trial in Malawi: economic analyses of results for policy discussion. Ministry of Agriculture and Livestock Development. Lilongwe, Malawi. 27 pp.

Benson, T.D. 2000. Profile of poverty in Malawi, 1998. National Economic Council. Lilongwe, Malawi.

Berger, M., V. DeLancey and A. Mellencamp. 1984. Bridging the gender gap in agricultural extension. ICRW and USAID. Washington, D.C. 74 pp.

Bindlish, V. and R. Evenson. 1993. Evaluation of the performance of T&V extension in Kenya. World Bank Tech. Paper # 208. World Bank. Washington, D.C. 161 pp.

Blackie, M.J., T.D. Benson, A. Conroy, R. A. Gilbert, G. Kanyama-Phiri, J.D.T. Kumwenda, C. Mann, S. Mughogho and A. Phiri. 1998. Malawi: soil fertility issues and options. Rockefeller Foundation – Lilongwe, Malawi. 55 pp.

Buckles, D., B. Triomphe and G. Sain. 1998. Cover crops in hillside agriculture: farmer innovation with *Mucuna*. IDRC and CIMMYT. Ottawa, Canada and Mexico City. 219 pp.

Doss, C.R. 2001. Designing agricultural technology for African women farmers: lessons from 25 years of experience. World Dev. 29:2075-2092.

Doss, C.R. and M.L. Morris. 2001. How does gender affect the adoption of agricultural innovations? The case of improved maize technology in Ghana. Agric. Econ. 25: 27-39.

Due, J.M. and C.H. Gladwin. 1991. Impacts of structural adjustment programs on African women farmers and female-headed households. Amer. J. Agr. Econ. 73:1431-1439.

Due, J.M., F. Magayane and A.A. Temu. 1997. Gender again – views of female agricultural extension officers by smallholder farmers in Tanzania. World Dev. 25: 713-725.

Evenson, R. E. 1992. "Agricultural extension and women farmers: evidence from Kenya and Burkina Faso." Paper presented at Fourteenth Annual Middlebury College Conference on Economic Issues on "Women in Development: Contributions to an Ongoing Agenda," April 3-4, Middlebury College, Middlebury, VT.

Gilbert, R.A. 1998. Comparison of best bet soil fertility interventions: preliminary results. pp. 225-227. In: Annual report of for the cereals commodity group for 1997-98. Ministry of Agriculture and Irrigation. Lilongwe, Malawi.

Koopman, J. 1993. The hidden roots of the African food problem: looking within the rural household. pp. 82-103. In: N. Folbre et al. (Eds.) Women's work in the world economy. University Press. New York, NY.

Kumar, S.K. 1987. Women's role and agricultural technology. In: J.W. Mellor et al. (Eds.) Accelerating food production in sub-saharan Africa. Johns Hopkins University Press. Baltimore, MD.

Lorenzetti, F., S. MacIsaac, J.T. Arnoson, D.V.C. Awong and D. Buckles. 1998. The phytochemistry, toxicology and food potential of velvetbean (*Mucuna Adans* spp., Fabaceae). pp. 67-84. In: (Buckles et al., eds.) Cover Crops in West Africa: Contributing to Sustainable Agriculture. IDRC/IITA/SG2000. Ottawa 291 pp.

Quisumbing, A.R. 1996. Male-female differences in agricultural productivity: methodological issues and empirical evidence. World Dev. 24: 1579-1595.

Rukuni, M., M.J. Blackie, and C. Eicher. 1998. Crafting smallholder-driven agricultural research systems in southern Africa. World Dev. 6:1073-1087.

Saito, K.A., H. Mekonnen and D. Spurling. 1994. Raising the productivity of women farmers in sub-saharan Africa. World Bank Discussion Paper # 230. World Bank. Washington, D.C. 110 pp.

Saito, K.A. and D. Spurling. 1992. Developing agricultural extension for women farmers. World Bank Discussion Paper # 156. World Bank. Washington, D.C. 105 pp.

Saito, K.A. and C.J. Weidemann. 1990. Agricultural extension for women farmers in Africa. World Bank Discussion Paper # 103. World Bank. Washington, D.C. 57 pp.

Smale, M., and P. W. Heisey. 1997. Maize technology and productivity in Malawi. pp. 63-79. In: (Byerlee and Eicher, eds.) Africa's Emerging Maize Revolution. Lynne Reiner. Boulder, CO. 301 pp.

Smale, M., and A. Phiri, with contributions from G.A. Chikafa, P.W. Heisey, F. Mahatta, M.N.S. Msowoya, E.B.K. Mwanyongo, H.G. Sagawa and H.A.C. Selemani. 1998. Institutional change and discontinuities in farmers' use of hybrid maize seed and fertilizer in Malawi: findings from the 1996-97 CIMMYT/MoALD survey. Economics Working Paper 98-01. Mexico, D.F. CIMMYT.

Staudt, K. 1975. Women farmers and inequities in agricultural services. Rural Afr. 29: 81-93.

The authors would like to acknowledge the financial support of The Rockefeller Foundation and the World Bank in the implementation and analysis of this trial, as well as the diligent efforts of the MPTF members and MoAI technicians and extension agents in Malawi. This research was supported by the Florida Agricultural Experiment Station, and approved for publication as Journal Series No. R-08956.

Reference Style: The following is the suggested format for referencing this article: Gilbert, Robert A., Webster D. Sakala and Todd D. Benson. "Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a9.htm

Agroforestry Innovations in Africa: Can They Improve Soil Fertility on Women Farmers' Fields?

CHRISTINA H. GLADWIN, JENNIFER S. PETERSON, AND ROBERT UTTARO

Abstract: Most observers agree that the verdict is still out for agroforestry innovations known as improved fallows, which may take a decade for farmers to test properly. First farmers plant several small plots of different tree species, cut them after two years and plant a cash or food crop, and then wait to see the results of that harvest. Because the improved fallow cycle takes four or five years, farmers' adoption or adaptation of this technology takes a lot longer than adoption of an improved seed or a new fertilizer. Until the experiment fails, African farmers – like most researchers – are willing to experiment, probably due to the lack of other options available as soil fertility amendments in Africa today. This is especially true for women farmers, even more so for female headed households whose lack of adult family labor presents them with severe cash and credit constraints. This paper describes their adoption decision processes when presented with new agroforestry technologies such as improved fallows in western Kenya, southern Malawi, and eastern Zambia.

Introduction

Agricultural experts claim that the food security situation in Africa now is analogous to the situation of Asia 40 years ago and Latin America 30 years ago, before the Green Revolution transformed both continents and enabled them to structurally transform their economies from being overly dependent and dominated by a stagnant agricultural sector to becoming more diversified with fledgling but growing manufacturing, services, and agricultural sectors. [1] Until Asian and Latin American policy makers adopted development strategies that encouraged small farmers to increase their agricultural productivity on small landholdings by adopting yield-increasing inputs of production, this structural transformation was not possible.[2]

The bio-physical root cause of low per capita food production is soil fertility depletion; the nutrient capital of African countries is now being mined, just like mineral deposits of metals or fossil fuels. [3] Smaling et al. estimate that soils in sub-Saharan Africa are being depleted at annual rates of 22 kilograms per hectare (kg/ha) for nitrogen (N), 2.5 kg/ha for phosphorus (P), and 15 kg/ha of potassium (K). [4] Soil fertility depletion is all the more alarming, given that

Christina H. Gladwin is professor, Food and Resource Economics, Box 110240 IFAS, University of Florida, Gainesville, FL 32611. **Jennifer Sheffee Peterson** holds a Masters in Agronomy and Agricultural Education from the University of Florida and is presently a consultant for Africare in Niamey, Niger. **Robert Uttaro** is a Ph. D. candidate in Political Science at the University of Florida and is finishing his dissertation on the politics of fertilizer in Malawi.
They are very grateful for the help and hospitality of farmers interviewed in southern Malawi and eastern Zambia as well as advisors in ICRAF and World Vision. They alone are responsible for errors and omissions in this text.

http://www.africa.ufl.edu/asq/v6/v6i1-2a10.pdf

ISSN: 2152-2448

recurring devaluations and removal of fertilizer subsidies, mandated by structural adjustment reforms, have made inorganic fertilizers unaffordable for most African smallholders. [5] In contrast to the situation when Asian and Latin American farmers were encouraged to intensify their crop production by adopting nitrogen-responsive crop varieties and increasing plant populations, African entrepreneurs face constraints that make it difficult for them to freely compete in an open fertilizer market. Among these factors are the small volume of fertilizer most African countries import, high transportation costs within most African countries, and high storage costs. [6] As a result, fertilizers are six to eight times more expensive at the farm gate in Africa than in Asia or Latin America.

Sanchez and colleagues of the International Center for Research on Agroforestry (ICRAF) recommend a two-pronged strategy to stop this mining, the first to replenish phosphorus nutrients and the second to replenish nitrogen. The first strategy involves the high phosphorous fixing soils of Africa, an estimated 530 million hectares where phosphorus-fixation is now considered an asset, and not a liability as previously thought. Here, inorganic phosphorus fertilizers are necessary to overcome phosphorus depletion on these soils. [7] Large applications of phosphorus fertilizer can become "phosphorus capital" as sorbed or fixed phosphorus, almost like a savings account, because most phosphorus sorbed is slowly *desorbed* back into the soil solution during 5-10 years. The larger the initial application rate, the longer the residual effect. If phosphorus is applied as a one time application of phosphate rock, it can be helped to desorb by the decomposition of organic inputs that produce organic acids to help acidify the phosphate rock, e.g., the organic acids in tithonia (*Tithonia diversifolia*), a common shrub in western Kenya.

While phosporus replenishment still requires an externally sourced chemical input that may be beyond the reach of the small farmer, this is not necessarily the case for nitrogen.

To reverse nutrient depletion of nitrogen in African soils, a second strategy exists, namely an increased use of organic sources of nitrogen nutrients. The organic sources of nitrogen include: animal manures and compost, biomass transfers of organic matter into the field, and also more efficient use of trees and shrubs whose deep roots capture nutrients from subsoil depths beyond the reach of crop roots and transfer them to the topsoil via decomposition of tree litter. By strategic planting of trees, nitrogen lost over the last 20 years can be replenished with nitrogen from agroforestry innovations such as hedgerow intercropping with leucaena (*Leucaena leucocephala* (Lam.) De Wit), biomass transfer with tithonia, manures improved with calliandra (*Calliandra calothyrsus* Meissner), and improved fallow systems using nitrogen-fixing shrubs like sesbania (*Sesbania sesban*), tephrosia (*Tephrosia vogelii*), pigeon pea *(Cajanus cajan),* and gliricidia (*Gliricidia sepium*).

Questions persist about this innovative approach to Africa's soil degradation crisis, however, and center on the issue of whether the nitrogen demands of food crops can be met in full with only organic sources of nutrients. ICRAF scientists claim that biophysically, organic sources can produce mid-range level yields of 4 tons/ha, but not the 6 tons/ha that could result from combinations of organic and inorganic fertilizers. Such combinations are needed because recovery of nitrogen by the crop from leaves of leguminous plants is lower (10-30%) than recovery from nitrogen inorganic fertilizers (20-40%). To reach these higher crop yields, more research is needed on the synergistic effects of combining the different kinds of organic and inorganic fertilizers. [8]

AGROFORESTRY INNOVATIONS: A SOLUTION FOR AFRICAN WOMEN FARMERS?

Whether or not this innovative approach to replenishing Africa's soil fertility is a success is likely to depend on its adoption by African rural women, who by custom produce the food crops in many African societies, while men produce the export crops. [9] As food producers, women farmers are the key to *reversing the crisis* and increasing domestic food production in Africa. Yet their lack of power inside their own households is a unique problem facing them in their roles as African food producers; food producers in Asia and Latin America, although small farmers, were not similarly constrained during the time of their Green Revolution. This is what we call the *invisibility factor* in the African food security literature, most of which is de-linked from the women in development (WID) literature. Food security analysts correctly argue that development strategies need to reach African smallholders to be effective, but they ignore the fact that the constraints facing women smallholders may be an important part of the problem. Eicher, for example, consistently does not mention that 45% of the smallholders responsible for Zimbabwe's second Green Revolution (1980-1986) are women; nor does he indicate the percentage of hybrid maize adopted by women nor the percentage of fertilizer subsidies benefiting women. [10] Similarly, Smale's report on Malawi's *delayed* Green Revolution does not indicate women's adoption of hybrid maize; [11] yet women's maize varieties, as shown here by Uttaro, are mostly local maize varieties, while hybrid varieties are mostly cash crops sold by men.

Because women farmers are such important players in African agriculture, the success of any strategy to replenish African soils needs to answer questions such as: will women farmers adopt agroforestry innovations to provide their soils with needed nitrogen, or will they face constraints to adoption more severe than those facing men farmers? Will women have more limiting factors to adoption? Do women have different motivations and reasons to adopt than men? Finally, do women in female headed households (FHHs) differ from women in male headed households (MHHs), and are the former more constrained than the latter?

Previous ethnographic and policy research suggest women have more limiting factors to adoption than men. Rocheleau finds an interaction between gendered property relations and gendered resource uses, user groups, landscapes, and ecosystems in Western Kenya, a region where agroforestry had been practiced since the 1600s. [12] As population increased and fallow lands became smaller and trees more scarce, people began planting trees, since they were no longer able to gather as many products from the forest and communal lands. Women did not own land but played an important role, as decisions about where sons would cultivate was the mother's; while wives and daughters also had usufruct rights to the land and its products. With the advent of land reformation laws in 1956, men aged 18 and over were automatically entitled to land titleship by the colonial government. [13] This policy lowered women's status in the lineage system since sons no longer had to go through their mothers to acquire land. Women's rights to land, trees, animals and water became subject to male permission. Today, however, with the implementation of more and more agroforestry projects in the area and continued decreases in fallow lands, women have begun to plant trees despite the traditional taboo that holds that bad luck will ensue should they do so.

Scherr finds that gender differences in agroforestry practices are still quite significant. [14] In one study, men had 50% more trees on their farms and almost 30% higher tree density. Men tended to plant trees in cropland while women's farms had more trees used primarily for fuelwood. These differences reflect men and women's differential ability to independently decide how trees will be used and allocated. Women are not permitted to make decisions without consulting their husbands, and are also less likely to question men or their policies at the institutional and state levels. This power differential between men and women lays the foundation for gender bias from household level decisions to policy level decisions.

AGROFORESTY ADOPTION DECISION TREE MODELS

In order to definitively answer questions about whether or not factors like power differentials influence agroforestry adoption decisions, in this paper we propose a testable model of the adoption decision process, and test it on a gender-disaggregated sample of both adopters and non-adopters. Here, as in the paper by Uttaro, we use "ethnographic decision trees" or *hierarchical* decision models [15] whose usefulness comes from their relatively high prediction rate: at least 80% of the historical choices made by farmers interviewed in an area are predicted by a decision tree model. Previously, decision tree models have been used to predict farmers' choices between chemical fertilizer and manure in Guatemala and Malawi, to increase fertilizer use in Mexico, to use credit for fertilizer in Mexico, Malawi, and Cameroon, to adopt other agroforestry technologies such as hedgerow intercropping in Kenya and Malawi, and to use grain legumes as soil-fertility-amendments in Malawi and E. Zambia. [16]

Decision trees predict because they are *cognitive-science* models, which aim to process information in the same way humans do, [17] as opposed to *artificial-intelligence methods* which are not so concerned with modeling the exact process that humans use but seek some alternative processing technique that approximates the human solution, e.g., linear programming models or multiple regression models of choice (probit, logit, and tobit analysis). Because cognitive science models aim to represent psychological reality and to mimic the mental processes people use, they should be better descriptions of human information processing and better predictors of human choice than are artificial-intelligence models.

When a decision tree is correctly specified, it allows the research team to identify the main factors limiting adoption at a specified time, and if possible, to recommend policy intervention to alleviate these constraints and speed up adoption. [18] These limiting factors may change or disappear over time, however; and the model is assumed valid only for the time period during which it is tested and should be retested at later times. Given low adoption rates, the research team may gradually conclude that the chances of much future adoption of the technology are not good, if there are a number of structural factors persistently blocking adoption (e.g., lack of land) that are *not* amenable to policy intervention (as opposed to limiting factors that are easily changed, e.g., lack of knowledge or seeds or credit). In this case, the usefulness of the adoption decision tree model is in sending the designers of the technology, the biophysical scientists, back to the drawing board to redesign.

Such was the case of the first application of decision tree modeling to agroforestry innovations, e.g., hedgerow intercropping (HI), implemented in on-farm trials in Western Kenya since the late 1980s. Much adoption work has been done by ICRAF social scientists using ethnographic decision tree modeling on the adoption and expansion of hedgerow intercropping (HI) or alley cropping. [19] Their work showed that women farmers' constraints of lack of knowledge, labor, and land did not allow many of them to plant hedges of leucaena or calliandra in between rows of maize, the subsistence crop. Their conclusions were matched by those of Deirdre Williams of the University of Florida Soils Management CRSP (collaborative research support program supported by USAID) project, "Gender and Soil Fertility in Africa." [20] Williams also interviewed 40 women farmers in Maseno, western Kenya, and found less than 20 percent adoption (Gladwin et al. 1997: 225-227), due to a number of structural factors blocking adoption (e.g., lack of land (5 cases) and labor (4 cases)) as well as limiting factors more amenable to policy change (e.g., lack of knowledge (15 cases) and seeds (2 cases) and termite problems (2 cases)). [21] She concluded the future chances of women's adoption of HI in western Kenya were not good.

Williams also modeled women farmers' decisions to adopt or not adopt biomass transfer innovations with a subsample of 23 women farmers in western Kenya. [22] Biomass transfer involves the use of leaves and strems from shrubs (*Tithonia diversifolia* and *Lantana camara*) for mulch. These shrubs are homestead border markers found everywhere in rural western Kenya, are under the control of women, but are traditionally used for goat fodder and medicine for stomach ailments and not for mulch. Williams model of women farmers' decisions *not* to use tithonia leaves and cuttings as mulch on their food crops shows why. In this decision tree, for brevity not presented here, more than half the women in the test sample did not pass the first two constraints, "Have access to tithonia or lantana shrubs growing nearby?" and "Know about this technology?" Other constraints included women's lack of labor: many female heads of households and women with small children felt they did not have the time themselves or access to the labor required to cut and carry enough biomass from these shrubs to adequately mulch their crops. The amount of biomass required to produce significant soil fertility benefits is *very* large; by some estimates, 7 tons per hectare of leafy dry matter (and triple that for fresh biomass) is being used in ICRAF's biomass transfer experiments. [23] Other women had problems with termites coupled with no farming practice (like putting on ash) to help with this problem; still others felt they needed the tree or shrub more for fodder or medicine than for soil improvement. The cumulative result of all these constraints was that the decision model predicted only four of the 23 women in the test sample should use tithonia for soil improvement.

The trees are relatively simple to design and test, as Uttaro's model of the decision to adopt improved fallows (IF) in figure 1 shows, read from top to bottom. [24] They have alternatives in set notation ({ }) at the top of the tree, decision outcomes in boxes ([ ]) at the end of the paths of the tree, and decision criteria in diamonds (< >) at the nodes of the tree. There are only two alternatives or decision outcomes in this set, [Plant an improved fallow now] and [Don't Plant now] and they are mutually exclusive. The only trick to the trees is *eliciting* the decision criteria from the decision makers themselves, who are the experts in making their decisions. They alone know how they make their choices, and so their decision criteria should be elicited from them in ethnographic interviews and by participant observation and other participatory methods (e.g., role playing).

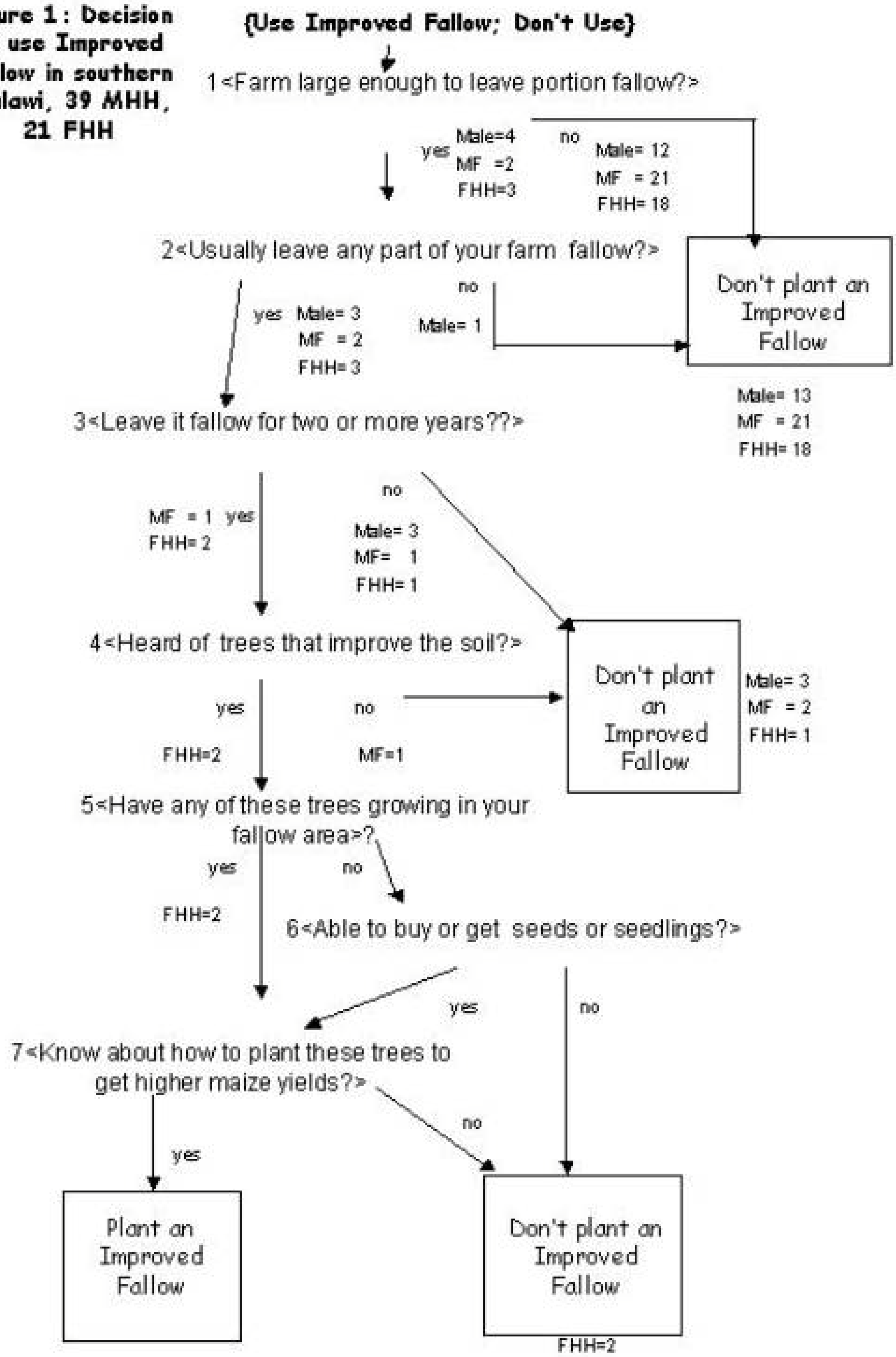


Figure 1: Decision to use Improved Fallow in southern Malawi, 39 MHH, 21 FHH

Given a particular sample of data from decision makers who have decided to both adopt and not adopt improved fallows, e.g., Uttaro's sample of 60 farmers interviewed in Zomba, southern Malawi, in 1998, one can *test* the tree easily by putting the data from each individual choice (as a separate, independent case, like a Bernoulli trial) down the tree and counting the errors in prediction on each path. Results of testing this model shows that lack of land was the most serious constraint to IF adoption in the Zomba region: most of the households in his sample engaged in continuous cropping. Nine informants (15%) had farms large enough to leave part of it fallow; and eight (13%) *usually* left part of the farm fallow (criteria 1 and 2). Only three of the eight farmers left their land fallow for two or more years (criterion 3). Of the three informants left, only two FHHs had any trees or shrubs that improve soil fertility in fallow areas (criterion 5); and they both lacked the knowledge of how to plant an improved fallow so that they would get higher yields after returning the land to maize production (criterion 7). In short, no farmer of the 60 used improved fallows. The gender-disaggregated data, moreover, show women face no additional constraints limiting their adoption of improved fallows.

The future prospects for improved fallow systems in two heavily-population regions of Africa (southern Malawi, western Kenya) would thus appear to be poor. Even if information was disseminated about the use and management of trees and bushes in fallow systems, farmers would still need to have land available to place into fallow. And with population growth rates among the highest in Africa, that is something unlikely to occur in both southern Malawi and western Kenya.

EASTERN ZAMBIA: THE EXCEPTION THAT PROVES THE RULE?

Our initial ethnographic results in African locations prior to 1998 were discouraging, as they showed women farmers tend *not* to adopt agroforestry innovations such as biomass transfers, hedgerow intercropping, and improved fallows. Why? Their main limiting factors were lack of knowledge of the new technology, lack of access to seeds or seedlings, and cash or credit to acquire them. Yet structural factors -- lack of land and labor -- were also limiting women's adoption, and in our judgment, they posed more serious problems to adoption prospects than the factors more amenable to policy intervention such as lack of knowledge or seedlings. Moreover, they were much more severe for women than men, and even more severe for female-headed households. We were therefore discouraged about the chances of agroforestry innovations replacing inorganic fertilizers as women's soil fertility amendments in the near future.

But could we extend these results to all of sub-Saharan Africa? In a word, no. Conditions in Africa are so diverse, so location-specific, so dependent on historical contingencies and socio-economic specificities (note the postmodern influence here) that results that hold in Western Kenya and Malawi cannot easily be generalized to other locations in Africa. Recent research results from ICRAF's on-farm trials of improved fallow systems with *Sesbania sesban* in Eastern Zambia seem to agree. [25] In 1988, ICRAF began to test improved fallow technologies at Msekera Research Station, Eastern Zambia, and in 1992/93 some on-farm trials of the improved fallows began in four villages chosen by ICRAF scientists to be representative of the diverse agro-climatic, socioeconomic conditions in the eastern Zambia region.

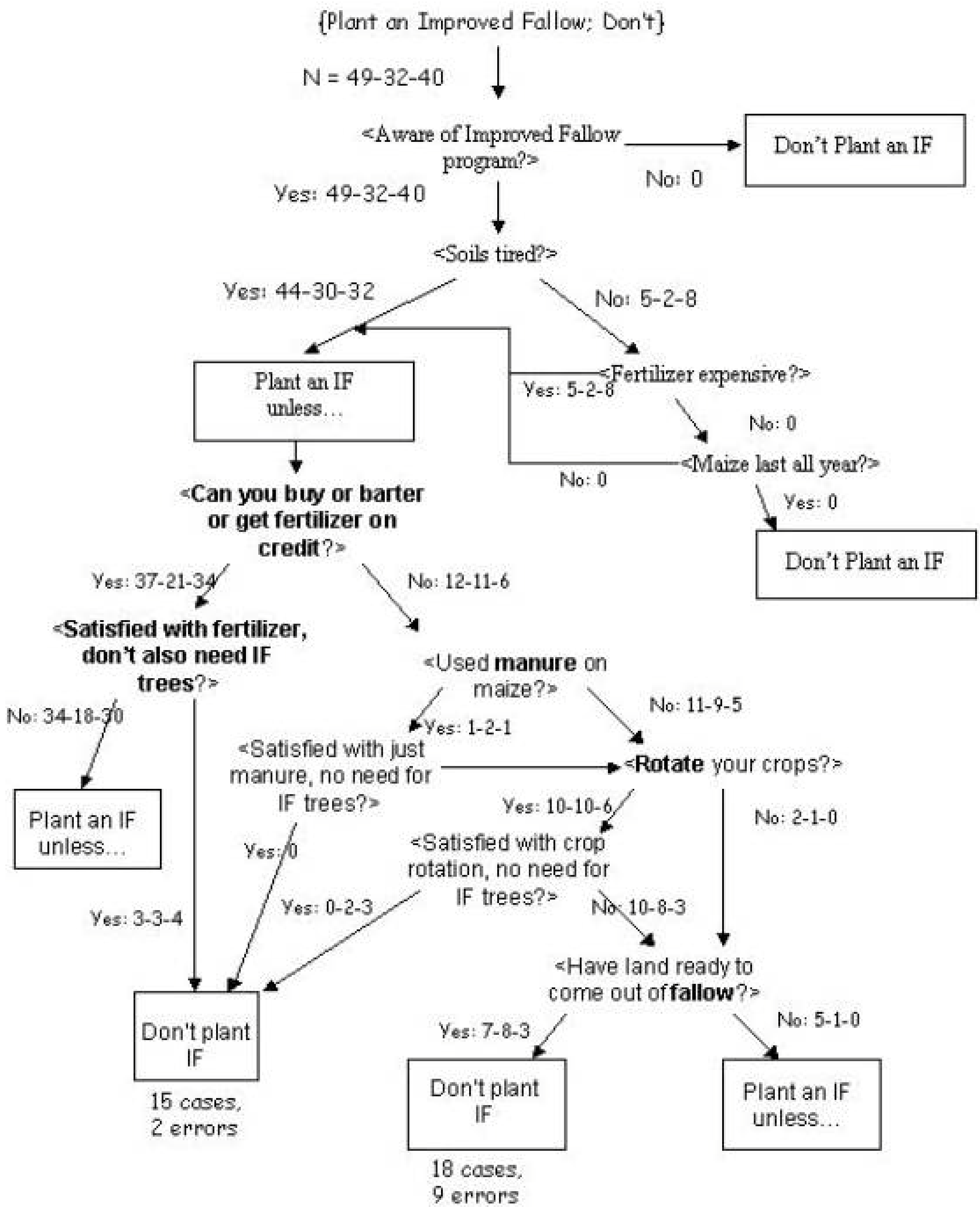
Small plots of improved fallows, ranging in size from 10 meters by 10 meters to 30 meters by 20 meters, are planted for two years with nitrogen-fixing tree species (*Sesbania sesban* or *Gliricidia* seedlings or direct-seeded *Tephrosia vogelii* or *Cajanus cajan* (pigeon pea)), and followed by two or three years of maize. By far the most promising, although it may look like a "dinky little tree," is sesbania, grown in a *dimba* nursery three to six weeks before the rainy season. Results over the five year cycle showed improved fallows increased total maize production 87% over unfertilized maize (even without any yield in years one and two); although estimates varied about the advantage of IFs over fully-fertilized maize (with 112 kg N/ha). Kwesiga and Beneist found maize yields following two-year improved fallows approach those of fully fertilized fields, [26] but Franzel et al. found fully-fertilized maize yielded 2.5 times more than IFs over five years. [27] The differing estimates did not matter for farmers, however, because with the rising prices of fertilizer in the Eastern Province, fully fertilized maize was no longer an option. In many cases even partially fertilized maize was not an option because farmers had neither the cash nor the access to credit to purchase fertilizer. By 1997, therefore, the multi-year trials of improved fallow technologies (IF) were a major success story: over 3000 farmers had participated, 49 percent of whom were women farmers. In 1998/99, USAID sponsored an extension project managed by World Vision (WV), an NGO operating in Africa to improve food security. The aim of the five-year WV project was to extend improved fallow technologies to the entire region of eastern Zambia with the aim of reaching 50,000 farmers, not just the farmers in the four villages in which ICRAF was concentrating its on-farm trials. By fall 2001, the WV project had registered 10,000 farmers in the region as participants in on-farm tests of IF technologies.

These numbers suggest that the IF technologies are a major success story at a time when Africa can boast of few success stories. Yet the question still unanswered is: *why* are improved fallows being adopted so readily in Eastern Zambia, especially by women, and not in southern Malawi right across the border? Is their success due to the fact that E. Zambia is a region of lower population density than the other regions so that women farmers have enough land to put some of it in fallow, or is it just a delayed reaction to structural adjustment policies that have raised the price of inorganic fertilizers to levels so high that women farmers have finally "adjusted" by deciding to "grow their own fertilizer" and adopt a substitute soil-fertility amendment? To answer this question, Jen Scheffee Peterson of the UF project, "Gender and Soil Fertility in Africa," in collaboration with ICRAF and later World Vision, interviewed women farmers who both were and were not testing and expanding their on-farm trials of improved fallows.

To elicit decision criteria from them, men and women adopters and non-adopters were interviewed in 1998 using open-ended eliciting techniques described by cognitive anthropologists, first by Peterson with three women in each of the four villages targeted by ICRAF with on-farm trials of improved fallows since 1992/93. Profiles of each farmer and stories about each farmer's adoption process were then formulated, and an initial "composite model" was built to represent the decision process of the group of 12 farmers interviewed. Gladwin and Peterson then jointly refined Peterson's initial composite model during another 18 interviews in June, 1998, and designed a questionnaire so that Peterson could test the revised decision model (figures 2 and 3) during personal interviews with another test sample of 81 women farmers and 40 men farmers who also resided in the camps surrounding ICRAF's four target villages. [28] Women in both FHHs and MHHs were interviewed, as well as men so that there were three sub-samples. The samples were chosen, after discussions with Steven Franzel and Donald Phiri of ICRAF, such that half the sample of each gender would be *testers*, who planted at least one improved fallow plot, and half *non-testers*, who did not plant even one improved fallow plot. Half of the sample of testers would be *testers-expanders*, who planted at least two improved fallow plots, and half *testers-non-expanders*, who planted only one improved fallow plot. [29]

Different versions of the adoption decision model were tested first by Peterson using an Excel spreadsheet, and then by Gladwin using simple SPSS syntax programs, by including different criteria elicited from different decision makers. Different orderings of the decision criteria were also tested, although the order of the criteria does not usually affect the prediction rate of a simple {Plant an IF; don't} model. [30] The different orders and criteria generated different decision trees, some of which are presented elsewhere. [31] For brevity, only the model with the best fit to these data is included here. The model in figures 2-3 is a close approximation to the first model elicited by Peterson and Gladwin, so that it has "descriptive adequacy," meaning it matches informants' statements about how they decided to plant an improved fallow. It differs from the model first elicited in minor ways, however, by the inclusion of other criteria, which upon testing were shown to "cut" the sample of decision makers into adopters and non-adopters.

Figure 2. Model 1 Tested with ICRAF 4-Village Data, 1998, 121 cases (49 FHHs-32 MF-40 MHH)



Motivations to Plant Trees

The motivations to plant an improved fallow plot came from the very first interviews by Peterson, as nearly all women say they plant an improved fallow because their soils are tired (nthaka yosira/yoguga), fertilizer is too expensive (wodula ngako), and their maize harvest does not last all year until the next harvest. The model in figure 2 says that any one of these reasons is enough for a farmer to consider planting an improved fallow; and thus sends them (i.e., their data) to the outcome, "Plant an improved fallow unless." Note that in the E. Zambian sample, every farmer has at least one of these reasons to plant an improved fallow, and thus the whole sample passes on to the first set of "unless conditions" – conditions or constraints which will block a farmer from planting an improved fallow, even though she or he has a good reason to.

Constraints to Planting an Improved Fallow

Figure 2 also lists the first set of constraints. It is a subroutine asking farmers if they are already satisfied with their soil fertility amendments so that they do not also need to plant an improved fallow. Farmers are sent to the outcome, "Don't plant an improved fallow," if they can buy fertilizer, or barter for it, or get it on credit, and they're satisfied with the amount acquired; *or* they have used manure on field maize in the recent past, and they're satisfied with manure; *or* they rotate crops in the field, e.g., groundnuts with maize with cotton, and they're satisfied with their crop rotations; *or* they have land ready to come out of a natural fallow now.

Results of testing this subroutine of the model show that most farmers can either buy or barter or get fertilizer on credit; but whereas women (especially female headed households) are mostly bartering for fertilizer, men are mostly buying fertilizer. Almost no one gets credit for fertilizer in E. Zambia. Almost no one is satisfied with the amount of fertilizer that is acquired, as usually it is a big decrease from past use. In addition, almost no one uses manure on maize; it is saved for garden vegetables grown in the dimba in the dry season, not usually used on field maize. Finally, almost everyone rotates their crops as a soil fertility measure, but that does not satisfy their need for more soil fertility. Results further show there are a lot of errors with the fallow criterion, "Have land ready to come out of fallow now?"; but when we omit it (by running another version of the model without it) there are more errors in the model (29 vs. 21). We thus conclude that with these data, the fallow criterion clearly helps the prediction rate, so that it belongs in the model. [32]

If the farmer is satisfied, he or she – really his or her data -- is sent to the outcome [Don't plant an IF now]. If the farmer is not satisfied, and also feels a need for the soil fertility amendment of IF trees, he or she is sent to the outcome, [Plant an IF plot unless…], meaning the farmer must pass another set of constraints in order to go to the outcome [Plant an IF]. The latter constraints in figure 3 start with a benefits criterion, ("Have you ever seen the benefits of IFs in other people's fields?"). If yes, farmers are asked if they can wait two years to see the benefits. Because of the intense work of ICRAF in these four villages, most farmers have either seen the benefits of IF plots on their or their neighbors' land, so most can wait the two years until the maize harvest after the improved fallow.

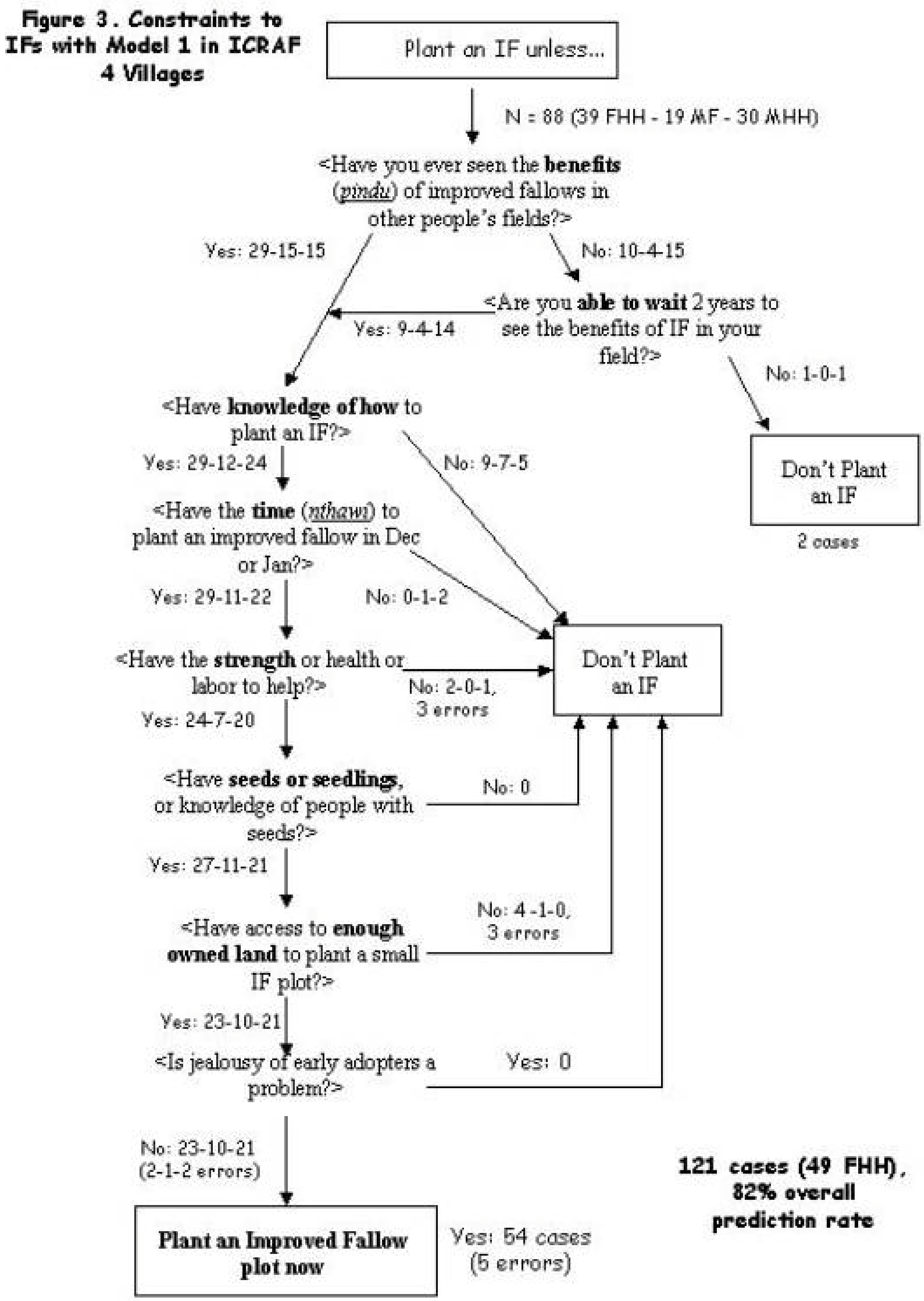


Figure 3. Constraints to IFs with Model 1 in ICRAF 4 Villages

The model thus tells us that farmers will plant an improved fallow: if they have a reason to plant one (their soils are tired, fertilizer is too expensive, or their maize harvest does not last all year) and they have seen the benefits of an improved fallow for themselves or can wait two years to see the benefits on their own plots, and they know how to plant one (planting the nursery, transplanting the seedlings, or direct-seeding tephrosia), and have the time the strength and health to do it, as well as access to seeds or seedlings and a small plot of land to experiment on.

Results show most (86) farmers in this sample proceed to the other constraints: lack of technical knowledge of *how* to plant the improved fallows (planting the nursery, transplanting the seedlings, or direct-seeding tephrosia), lack of time to plant an IF, lack of strength and health, lack of access to seeds or seedlings, and lack of land. In addition, farmers were asked if their only access to land was borrowed land (so they would not plant an IF), or if villagers' jealousy of early adopters of IF might be a problem. Results show only 54 of 86 farmers pass *all* these latter constraints and are predicted to adopt. The most important limiting factor (for 21 farmers) is lack of technical knowledge of *how* to plant an IF. Of the 86 farmers who make it down the tree to this constraint, lack of technical knowledge is a limiting factor for more married women (37%) than FHHs (24%) than men (17%). This gender difference is expected, based on previous WID literature showing women receive less extension training than men. [33] Women's lack of knowledge does affect adoption: this model predicts adoption for only 31% of the married women in MHHs compared to 47% of the FHHs and 52% of the men in MHHs. There are 22 total errors of the model, meaning the model successfully predicted 82% of farmers' choices.

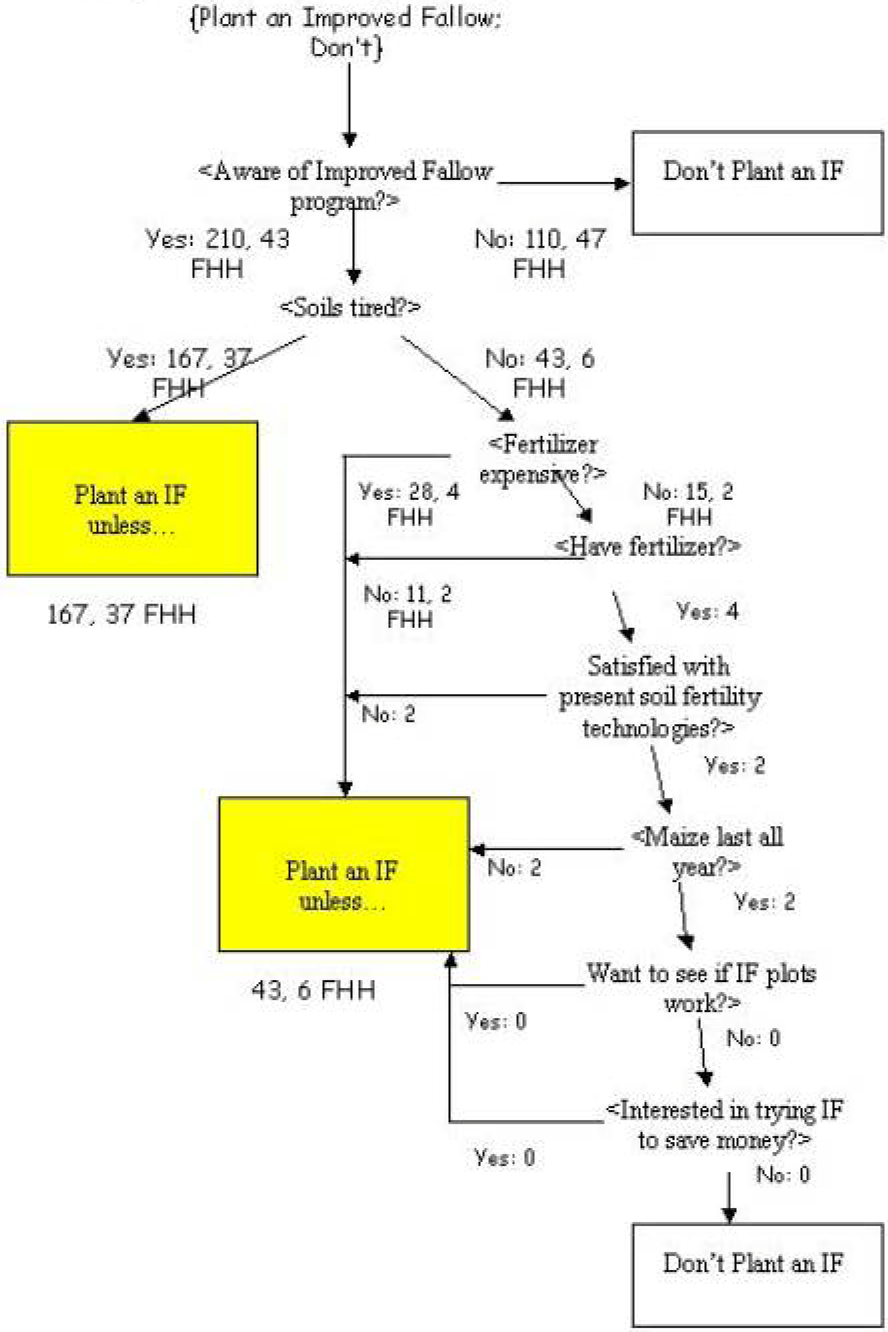
Testing The Same Decision Model on Another Sample

Some of the results of testing this model were as expected from the WID literature, e.g., that men adopt more than women in MHHs or FHHs. Other results were unexpected, e.g., women in FHHs adopt improved fallow technologies more than women in MHHs. These results were a surprise – although a welcome surprise – because results of the other studies done as part of the "Gender and Soil Fertility" project, seen in other papers in this issue, were quite dismal about the possibility of reaching FHHs with soil fertility improvements. For example, Uttaro's study in southern Malawi shows FHHs do not buy small bags of fertilizer; they are usually bought for mens' fields and/or "dimba" cash crops, even if bought by women in local shops. Neither do FHHs grow grain legumes as soil fertility amendments, because the legumes are eaten as food rather than turned under "green." Sullivan's Senegalese study, for another example, shows that the only women apt to adopt credit for fertilizer use on hybrid rice would be older married women in extended-family households. Similarly, Gough's Malawi study shows that grants and vouchers for grants of fertilizer benefit FHHs, but only minimally: women's disposable cash incomes increase less than 10% from Malawi's starter pack program. Even cash crops in women's farming systems have minimal benefit to them, because women tend to skim the fertilizer received on credit for the cash crop and apply some of it on the food crop. As a result, they find they receive little cash income from the cash crop when it is sold and the credit repaid. Compared to these findings that do not paint a promising picture of government's being able to reach FHHs with soil fertility technologies, these results of FHHs' adoption of improved fallow technologies stand out as a remarkable successful story.

Fortunately we were able to further test these surprising results, because the World Vision extension project conducted a baseline survey in 1999 by Peterson et al., [34] before it began an ambitious project to diffuse improved fallows technologies from four villages to the entire eastern Zambia region. We thus included questions to test the decision model in figures 2 and 3 with survey data from 320 farmers (230 MHHs and 90 FHHs) living in 20 villages (called camps) spread across the eastern Zambia region, including districts of Chadiza, Chipata North, Chipata South, Katete, and Mambwe. In this target area, only 4% of the households – and only 2% of the FHHs – interviewed had enough maize to last all year from the 1997/98 farming season, and 50% of the households ran out of maize by December. [35] Household food insecurity was thus considered a major community problem in all the villages, and mentioned as the number one problem in 45% of the villages sampled. Fifty-eight percent (158/273) of the respondents described their soils as being depleted, while 22.5% considered them "moderate," and only 19% described them as good. [36] Here, there were some gender differences: 69% FHHs described their soils as depleted, compared to 54% MHHs. Ninety-four percent of the farmers surveyed had some knowledge of fertilizer use, although only 41% of those who had some knowledge actually used it, because of lack of cash. Similarly, 84% of the farmers had knowledge of manure, but only 40% of those with knowledge of manure actually applied manure in their fields or gardens (dimbas). The number practicing improved fallow technologies was even lower: 66% of farmers had heard of improved fallows before the last planting season, but only 21 farmers – 10% of those with knowledge, and 7% of all farmers interviewed – had planted an improved fallow. [37] Therefore, outside of the four villages where ICRAF concentrated its on-farm research, there was relatively little adoption of improved fallow technologies at the start of the World Vision extension project in the entire region of eastern Zambia.

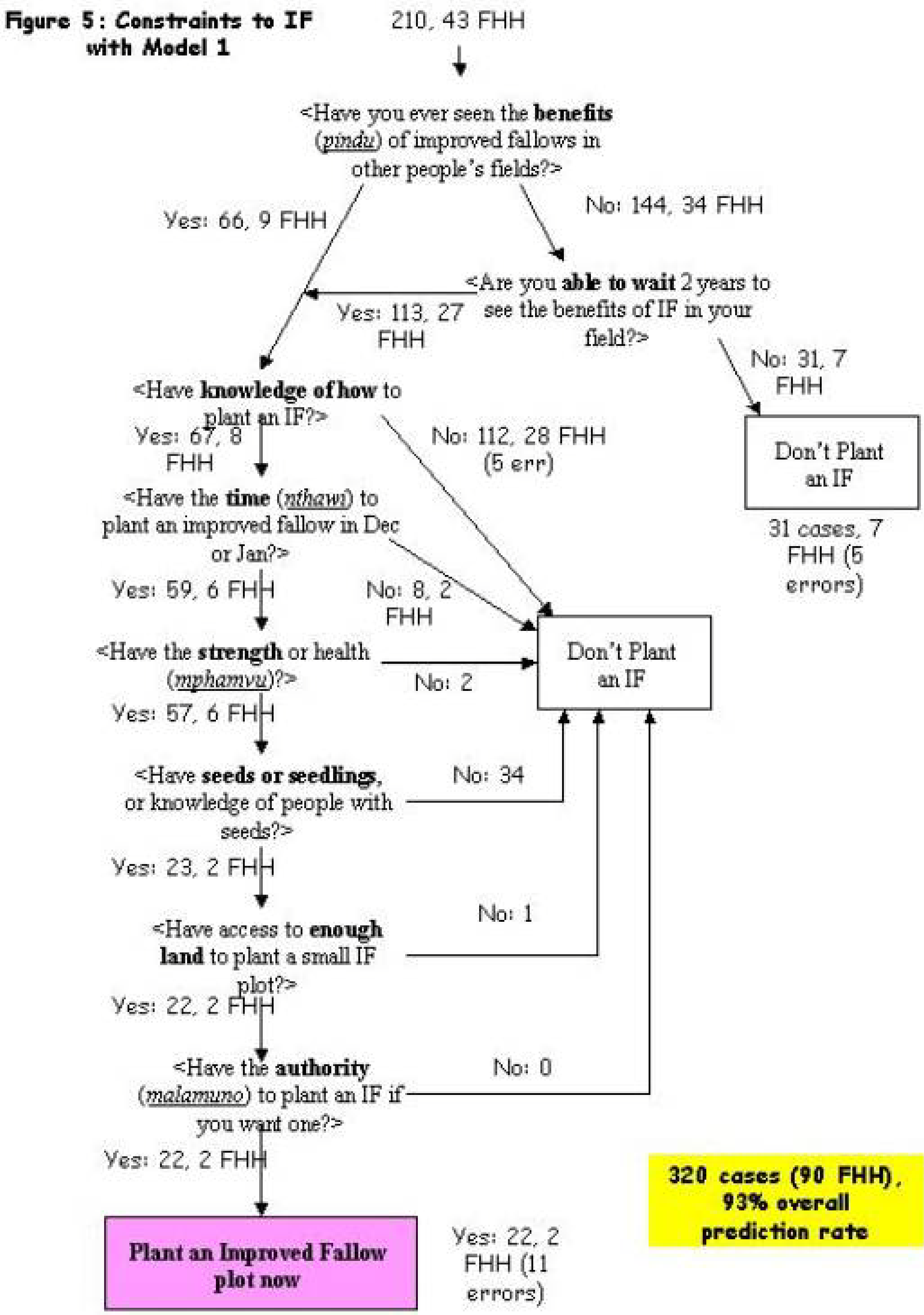
The decision tree model to adopt improved fallows (IF) in figures 2-3 was tested again with this sample (heretofore called the World Vision sample), via questions on the baseline survey that correspond to the criteria in figures 4-5. As before, farmers must have at least one reason or motivation to adopt an IF in figure 4, and have to pass all criteria or constraints to reach the outcome [Plant an IF] in figure 5. As before, results of testing the model are disaggregated by gender of household head.

Figure 4: Model 1 Tested with World Vision Baseline Data, 1999, 320 cases (90 FHHs)



What is different about the results in figures 4-5, now that the sample of decision makers is dispersed over the entire eastern Zambia region rather than being concentrated in the four villages ICRAF was planting on-farm trails in, is that one-third of the sample (110 of 320 farmers) and half of the FHHs (47 of 90 FHHs) are not aware of the ICRAF improved fallow program (criterion 1). They therefore go to the outcome [Don't plant an improved fallow (IF)], with no errors on this path. Again, it is expected that disproportionately more FHHs than MHHs lack awareness-knowledge of improved fallow technologies.

Only 210 farmers, including 43 FHHs, proceed down the tree to consider the reasons to plant an IF, such as "Soils tired?" (criterion 2), "Fertilizer expensive" (criterion 3), "satisfied with present soil fertility technologies" (criterion 5), "Maize last all year" (criterion 6). In addition to these figure-two criteria, Peterson et al. (1999) also asked farmers if they wanted to see if an improved fallow plot would work (criterion 7) and if they were interested in trying an improved fallow just to save money (criterion 8). Results in figure 4 show no farmer made it down the tree to process the latter two criteria; all farmers who passed the awareness-knowledge constraint in criterion 1 had a reason to plant an improved fallow, and thus they (i.e., their data) were sent on to the constraints in figure 5.



The list of constraints in figure 5 is identical to figure 3, except for the inclusion of an "authority" (malamuno) constraint (criterion 16), which Peterson elicited from women in the four ICRAF villages when reporting back to them about the results of her first personal survey.

At that time, she had asked why fewer married women adopted improved fallows, and the women replied, "malamuno", i.e., they did not have the authority to plant an improved fallow plot on their household's land without the husband's permission. When this criterion is included at the end of the path in figure 5, however, it doesn't "cut" the sample into adopters and non-adopters: no farmers say no, they don't have the authority and so do not plant an improved fallow.

Instead, as expected, the main limiting factor to adoption of improved fallows in figure 5 is how-knowledge of the IF technologies, which includes knowledge of how to plant a seedbed, how to transplant, how to prune and harvest the trees, etc. At this juncture in the decision process, 112 farmers, including 28 FHHs, do not know how to use the IF technology and so do not plant an improved fallow. After how-knowledge, the second main limiting factor is lack of seeds or seedlings: 34 farmers are sent to the outcome, [Don't plant an improved fallow] at criterion 14. Only 22 farmers in the World Vision baseline sample, including only 2 FHHs, are thus sent to the outcome, [Plant an improved fallow now]. There are, however, 11 errors in this sub-sample of "adopters." These errors may be due to some omitted criteria in this model, or incorrect phasing of the decision-criteria questions by the survey interviewers, or farmers' lack of understanding of the questions in the survey. Whatever the reason, there is a high error rate on this path.

Nevertheless, the overall prediction rate of farmer adoption behavior is 93 percent (299/320) in this World Vision sample, much higher than the 82% prediction rate of the same model in the ICRAF four-village sample. This difference in prediction rate between the two samples is surprising; we would expect lower prediction rates in tests conducted by third-party interviewers unfamiliar with the decision model, as "the fudge factor" is eliminated. We would therefore expect the World Vision sample, conducted by interviewers trained by Peterson, to have lower prediction rates than in the ICRAF sample. The unexpected high success rate in the World Vision sample, however, may be simply due to lack of variation in adoption behavior in the sample. In the 1999 baseline data sample from the World Vision project, almost no one (7% farmers) adopted improved fallows. In contrast, in the ICRAF sample, half (54%) of the farmers adopted while half (46%) did not. The greater variability in adoption behavior in the ICRAF sample, therefore, might be responsible for the lower prediction rates. Alternatively, the high success rates of the model in the World Vision sample may be due to the fact that for one-third of this sample, there was no awareness-knowledge of improved-fallow technologies and therefore no real choice for these 110 farmers to make. Clearly, the decision model should be tested again, as the improved fallow technologies diffuse, awareness-knowledge grows, and more farmers across the wider eastern Zambia region face a real choice about whether or not to plant improved fallows.

Conclusion

Results of testing decision tree models of farmer adoption behavior described here present mixed results on the potential of agroforestry technologies, as measured by the extent of farmers' adoption or acceptance of them as soil fertility amendments. Williams' 1997 results show adoption of hedgerow intercropping and biomass transfers by women farmers was poor in western Kenya. Uttaro's 1998 gendered-disaggregated results about the adoption of improved fallows in Zomba, southern Malawi, were similarly discouraging. In contrast, Peterson's 1999 results from eastern Zambia show that *women, especially FHHs, do adopt* improved fallow technologies, because they know their soils are depleted and they are not satisfied with the amount of fertilizer they can now afford to acquire by barter or purchase. Statistical results of estimating logit and ordered probit models presented elsewhere also confirm these results, and show that women in FHHs are *more likely* to adopt improved fallows than are married women or men in MHHs, holding constant other factors such as household size, age and club membership of the household head, and his/her ability to wait two years to see the benefits of an improved fallow. [38]

Taken at face value, therefore, improved fallow technologies appear to be one of the few success stories in sub-Saharan Africa today. Questions remain, however, about whether they will continue to diffuse. Results here suggest they should, as farmers increasingly realize they cannot afford to buy costly imported chemical fertilizers, and are therefore adjusting to the idea of "growing their own." Government policies, however, have a great deal of impact on whether or not improved fallows diffuse. [39] Policy makers who realize they cannot continue to give costly subsidies of either credit or fertilizers to farmers will tend to encourage adoption of improved fallow technologies; while governments who keep their exchange rate overvalued, fearing recurrent devaluations of their currencies, will not. This is because, as the decision models above show, it's the unaffordability of chemical fertilizers -- made more unaffordable with every devaluation of the local currency -- that leads farmers to adopt improved fallow technologies.

Whether or not improved fallow technologies can entirely substitute for nitrogen fertilizers, as suggested by ICRAF and Pedro Sanchez, also remains to be seen. Most observers agree that the verdict is still out for improved fallow technologies, which may take a decade for farmers to test properly. First farmers plant several small plots of different tree species, then they wait three to four years to see the results of each plot. Because the improved fallow cycle takes so long, farmers' adoption or adaptation of this technology takes a lot longer than adoption of an improved seed or a new fertilizer. Until the experiment fails, African farmers – like most researchers – are willing to experiment, probably due to the lack of other options available as soil fertility amendments in Africa today. This is especially true for women farmers, even more so for female-headed households whose lack of adult family labor presents them with severe cash and credit constraints. Being good farmers, they know they need to have as many tools as possible in their soil fertility toolbox, so that even if not applicable everywhere, the improved-fallow tool will be used where it is most appropriate.

Notes

1. Gabre-Madhin and Johnston 1999.
2. Tomich, Kilby, and Johnston 1995.
3. Sanchez et al. 1997.
4. Smaling et al. 1997: 52.
5. Bumb et al. 1996.
6. Pinstrup-Andersen 1992.

7. Jama et al. 1997.
8. Palm et al. 1997.
9. Gladwin and McMillan 1989.
10. Eicher 1982, Eicher 1995.
11. Smale 1995.
12. Rocheleau 1995.
13. Pala-Okeyo 1980.
14. Scherr 1995.
15. The term hierarchical decision models distinguishes decision trees from linear additive models such as linear regression analysis, probit analysis, or logit analysis. The term "hierarchical" refers to the fact that the decision criteria or dimensions are mentally processed in a certain order such that alternatives are compared on each dimension or criterion separately, and criteria or dimensions are ordered so that all of them may not be processed by all individuals. This simplifies the decision process considerably, and saves the individual cognitive energy. A linear-additive model, in contrast, assumes all the criteria or dimensions of each alternative are weighed by the decision maker, and each alternative is assigned a composite score, and the alternative with the highest score is chosen. Much debate about these two types of models of the search-for-information process has occurred between psychologists (Rachlin 1990: 76-77).
16. Gladwin 1976, 1989, 1991,1992; Swinkels and Franzel 1997, Williams 1997, Peterson 1999, Peterson et al. 1999, Uttaro 1998, D'Arcy 1998.
17. Simon 1979.
18. Gladwin 1976, 1979.
19. David 1992, Shepard et al. 1997, Swinkels and Franzel 1997.
20. Williams 1997.
21. Her research was conducted at various sites in and around Maseno, mainly in Siaya and Kisumu districts, home to mostly Luo and some Luhya people. A typical farm in this area is less than 1 hectare in size; mean household size is 7 people including 3 or 4 adults. Many farms have small coppiced woodlots (about 0.14 ha.) of *Eucalyptus saligna* but indigenous trees such as *Markhamia lutea* and *Sesbania sesban* are commonly found around homesteads, on boundaries, in croplands and in fallows. As mentioned, Luo women are traditionally forbidden to plant trees and although this custom is changing somewhat, men are still expected to make decisions about species type and placement of trees. If a woman takes care of or uses trees around the homestead, they generally still belong to her husband or his family, even after he dies (Rocheleau 1996). However, shrubs (specifically *Sesbania sesban*), are women's property and women are allowed to plant them in croplands, manage, use, and dispose of them as they see fit. This is also true among Luhya women. Moreover, men and women have different uses for tree products. Although resource use is not absolute and inflexible, in general, men prefer poles, timber and fodder from trees while women want fuelwood and fodder. Although both show interest in soil fertility improvement, women farmers have different sets of concerns regarding their soil fertility management strategies.

22. Williams used two samples of women, one to build the adoption models and one to test them. Both samples included female-headed households (*de jure* and *de facto*), members and non-members of women's groups (high to low resource, newly and well-established), and women generally considered to be of above-average, average, and below-average wealth according to such socio-economic criteria as farm size, house type, numbers and types of livestock etc. The sample of women used to build the models consisted of 25 Luo women while the sample used to test the models was made up of both Luo and Luhya women (10 and 13 respectively).
23. Jama et al. 1997.
24. Uttaro 1998.
25. Franzel et al. 1997, Kwesiga et al. 1997, Peterson 1999, Peterson et al.1999.
26. Kwesiga et al. 1999.
27. Franzel et al. 1997.
28. Peterson 1999.
29. At first it was planned to find 40 women who began testing improved fallows before 1995/96 in the four target camps. This was impossible, however, as only 28 women tested IFs before 1995/96, because most of the early testers were men. In many instances, however, farmers were so convinced of the success of the technology (especially after having visited farmers in other camps as part of field days or farmer-to-farmer visits) that they did not wait until they harvested their first IF before they planted another. Of the 81 women in the ICRAF sample, Peterson interviewed 40 non-testers, 23 tester-expanders, and 18 tester-non-expanders; of the 40 men, she interviewed 15 non-testers, 16 tester-expanders, and 9 tester-non-expanders (Peterson 1999:4).
30. Gladwin 1989: 72.
31. Gladwin et al. 2002.
32. However, a more complicated subroutine may have to replace the simple criterion used here which assumes natural and improved fallows are substitutes for each other, e.g., add an additional constraint, "Do you have time and strength to clear this land?"
33. 33 Staudt 1975.
34. Peterson et al. 1999.
35. Peterson et al. 1999: 89.
36. Peterson et al. 1999: 65.
37. Peterson et al. 1999: 68.
38. Gladwin et al. 2002.
39. Place and Dewees 1999.

References

Bumb, B.L., Teboh, J.F., Atta, J.K., and Asenso-Okeyre, W.K. "Policy Environment and Fertilizer Sector Development in Ghana." Paper presented at the National Workshop on Soil Fertility Management Action Plan for Ghana, Efficient Soil Resources Management: A Challenge for the 21st Century. Cape Coast, Ghana, July 2-5, 1996.

D'Arcy, R. "Gender and Soil Fertility Project Report: Dowa, Malawi." Gainesville, FL: Report to the University of Florida Soils Collaborative Research Support Project, 1998.

David, S. "Open the Door and See All the People: Intra-Household Processes and the Adoption of Hedgerow Intercropping." Paper presented at the Rockefeller Foundation Social Science Fellows' Meeting, CIMMYT, Mexico, November 9-13, 1992.

Eicher, C.K. "Facing Up to Africa's Food Crisis." Foreign Affairs 61 (1982): 151-174.

Eicher, C.K. "Zimbabwe's Maize-Based Green Revolution: Preconditions for Replication." World Development 23 (1995): 805-818.

Franzel, S., Phiri, D., and F. Kwesiga. "Participatory On-Farm Research on Improved Fallows in Eastern Province, Zambia." Chipata, Zambia: Zambia/ICRAF Agroforestry Research Project. 1997.

Gabre-Madhin, E.Z., and B.F. Johnston. "Accelerating Africa's Structural Tranformation: Lessons from East Asia." Paper presented at Tuskegee University Conference on Rural Development and Economic Performance in Africa, Atlanta, Georgia, April 19-21, 1999.

Gladwin, C.H. "A View of the Plan Puebla: An Application of Hierarchical Decision Models." American Journal of Agricultural Economics, 58(1976): pp. 881-887.

Gladwin, C.H. "Cognitive Strategies and Adoption Decisions: A Case Study of Non-Adoption of an Agronomic Recommendation." Economic Development and Cultural Change 28(1979): pp. 155-173.

Gladwin, C.H. Ethnographic Decision Tree Modeling. Sage Publications, Newbury Park, CA, 1989.

Gladwin, C.H. "Fertilizer Subsidy Removal Programs and Their Potential Impacts on Women Farmers in Malawi and Cameroon," In: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers. Gainesville, FL: University of Florida Press, pp. 191-216, 1991.

Gladwin, C.H. "Gendered Impacts of Fertilizer Subsidy Removal Programs in Malawi and Cameroon." Agricultural Economics 7 (1992): 141-153.

Gladwin , C.H., McMillan, D. "Is a Turnaround in Africa Possible without Helping African Women to Farm?" Economic Development and Cultural Change 37 (1989): 345-369.

Gladwin, C.H., Buhr, K.L., Goldman, A., Hiebsch, C.K., Hildebrand, P.E., Kidder, G., Langham, M., Lee, D., Nkedi-Kizza, P., and Williams, D., 1997. "Gender and soil fertility in Africa," in: Sanchez, P., and Buresh, R. (eds.), Replenishing Soil Fertility in Africa. Madison, WI: Soil Science Society of America Special Publication no. 51, pp 219-236, 1997.

Gladwin, C.H., Peterson, J.S., and Mwale, A. "The Quality of Science in Participatory Research: a Case Study from E. Zambia." World Development 30 (2002): 523-543.

Gladwin, C.H., Thomson, A.M., Peterson, J.S., Anderson, A.S. "Addressing Food Security in Africa via Multiple Livelihood Strategies of Women Farmers." Food Policy 26 (2001): 177-207.

Goheen, M. 1991. The ideology and political economy of gender: women and land in Nso, Cameroon. In: Gladwin, C.H. (Ed.), Structural Adjustment and African Women Farmers. University of Florida Press, Gainesville, FL, pp. 239- 256.

Jama, B., Swinkels, R., and Buresh, R.J. "Agronomic and Economic Evaluation of Organic and Inorganic Sources of Phosphorus in Western Kenya." Agronomy Journal 89 (1997): 597-604.

Kwesiga, F., S. Franzel, F. Place, D. Phiri, and C.P. Simwanza. "*Sesbania* Improved Fallows in Eastern Zambia: Their Inception, Development and Farmer Enthusiasm." Agroforestry Systems, 1999.

Pala-Okeyo, A. "Daughters of the Lakes and Rivers: Colonization and Land Rights of Luo Women,"in: Davison, J., ed. Land and Women's Agricultural Production: The African Experience. Boulder, CO: Westview Press, pp.185-213, 1980.

Palm, C.A., Myers, R.J.K., and Nandwa, S.M. "Combined Use of Organic and Inorganic Nutrient Sources for Soil Fertility Maintenance and Replenishment," in: Sanchez, P., and Buresh, R., eds. Replenishing Soil Fertility in Africa. Madison, WI: Soil Science Society of America Special Publication no. 51, pp. 193-217, 1997.

Peterson, J.S. "Kubweletza Nthaka: Ethnographic Decision Trees and Improved Fallows in the Eastern Province of Zambia." Report to the University of Florida's "Gender and Soil Fertility in Africa" Soils Management Collaborative Research Support Program (CRSP) and the International Centre for Research on Agroforestry (ICRAF), May, 1999.

Peterson, J.S., Tembo, L., Kawimbe, C., and Mwang'amba, E. "The Zambia Integrated Agroforestry Project Baseline Survey: Lessons Learned in Chadiza, Chipata, Katete and Mambwe Districts, Eastern Province, Zambia." Report to the World Vision International Zambia Integrated Agroforestry Project staff, the University of Florida's "Gender and Soil Fertility in Africa" Soils Management Collaborative Research Support Program, the International Center for Research on Agroforestry, and the Zambian Ministry of Agriculture, Food, and Fisheries, 1999.

Pinstrup-Andersen, P. "Fertilizer Subsidies: Balancing Short-Term Responses with Long-Term Imperatives," in N. Russell and C. Dowswell, eds. Policy Options for Agricultural Development in sub-Saharan Africa. Airlie House, VA: Center for Applied Studies in International Negotiations (CASIN)/ Sasakawa Global 2000, 1992.

Place, F., and P. Dewees. "Policies and Incentives for the Adoption of Improved Fallows." Agroforestry Systems 47 (1999): 323-343.

Rachlin, H. Judgment, Decision, and Choice. New York: W. H. Freeman and Co., 1990.

Rocheleau, D. "Women, Men, and Trees: Gender, Power, and Property in Forest and Agrarian Landscapes." Paper prepared for GENDER-PROP, An International E-mail Conference on Gender and Property Rights, 1995.

Sanchez, P., Izac, A.M., Buresh, R., Shepherd, K., Soule, M., Mokwunye, U., Palm, C., Woomer, P., Nderitu, C. "Soil Fertility Replenishment in Africa as an Investment in Natural Resource Capital." In: Buresh, R., Sanchez, P. (eds.) Replenishing Soil Fertility in Africa, SSSA Special Publication 51. Madison, WI: Soil Science Society of America (SSSA), 1997.

Scherr, S.J. "Economic Factors in Farmer Adoption of Agroforestry: Patterns Observed in Western Kenya." World Development 23 (1995), 787-804.

Shepherd, K.D., Ndufa, J.K., Ohlsson, E., Sjogren, H., and Swinkels, R. "Adoption Potential of Hedgerow Intercropping in Maize-Based Cropping Systems in the Highlands of Western Kenya: I. Background and Agronomic Evaluation." Experimental Agriculture 33 (1997), 197-209.

Simon, H.A. "On How to Decide What to Do." Bell Journal of Economics, 1979.

Smale, M. "Maize is Life: Malawi's Delayed Green Revolution." World Development 23 (1995): 819-831.

Smaling, E.M., Nandwa, S.M., Janssen, B.H. "Soil Fertility in Africa is at Stake." In: Sanchez, P., and Buresh, R. (eds.), Replenishing Soil Fertility in Africa. Madison, WI: Soil Science Society of America Special Publication no. 51, pp. 47-62, 1997.

Spradley, J.P. The Ethnographic Interview. Harcourt Brace Jovanovich College Publishers, Orlando, 1979.

Staudt, K. "Women Farmers and Inequities in Agricultural Services." Rural Africana 29 (Winter 1975): 81-93.

Swinkels, R., Franzel, S. "Adoption Potential of Hedgerow Intercropping Systems in the Highlands of Western Kenya: II. Economic and Farmers' Evaluation." Experimental Agriculture 33 (1997): 211-223.

Udry, Christopher. "Gender, Agricultural Production, and the Theory of the Household." Journal of Political Economy 104(1996): 1010-1046.

Uttaro, R.P. "Diminishing Returns: Soil Fertility, Fertilizer, and the Strategies of Farmers in Zomba RDP in Southern Malawi. Gainesville, FL: Report to the University of Florida Soils Collaborative Research Support Project, 1998.

Williams, D.E. Gender and Integrated Resource Management: the Case of Western Kenya. Masters' Thesis, University of Florida, Gainesville, FL, 1997.

Tomich, T.P., Kilby, P., Johnston, B.F. Transforming Agrarian Economies. Cornell University Press, Ithaca, N.Y. , 1995.

Reference Style: The following is the suggested format for referencing this article: Sullivan, Amy. "Agroforestry Innovations in Africa: Can they Improve Soil Fertility on Women Farmers' Fields." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a10.htm

African Studies Quarterly | Volume 6, Issues 1 & 2 | Spring 2002

Modeling Agroforestry Adoption and Household Decision Making in Malawi

PAUL H. THANGATA, PETER .E. HILDEBRAND, AND CHRISTINA H. GLADWIN

Abstract: Low resource farmers make decisions about adopting new technologies as part of the overall strategy for ensuring subsistence and cash income for their food security needs. This paper reports on a study conducted in Kasungu, Malawi, southern Africa, to evaluate the potential for small-scale farmers to adopt improved fallows. Simulations of two representative households, a male and a female headed, were carried out using dynamic ethnographic linear programming (ELP) in a ten-year model. Results show that the adoption pattern for improved fallows is driven by the amount of land and labor available rather than the gender of the household head. Female-headed households with insufficient labor may hire labor for other cropping activities, which enables them to plant improved fallows. Furthermore, simulations show that when households are able to sell seed from the woody species in the fallow, both male and female households stop taking credit for fertilizer for their cash crop. They still grow the cash crop, in this case tobacco, but produce most of their maize without chemical fertilizers. It is concluded that in Kasungu, Malawi, improved fallows will be adopted in households with sufficient land and labor.

Introduction

Soil fertility depletion is considered a major constraint for smallholder farmers in nutrient–poor tropical soils, especially in sub-Saharan Africa. High population pressure has led to land shortages and continuous arable cultivation without fallowing, leading to high nutrient losses in Malawi where agriculture is the mainstay of the economy. About 85% of the population in Malawi is rural and is dependent on agriculture. Long duration natural fallows that were traditionally used to overcome soil fertility depletion [1] are no longer possible due to increasing population pressures on the land. The decline in soil fertility has led to reduced soil productivity and hence more food insecure households. However, among other benefits,

Paul Thangata has received his PhD from the College of Natural Resources and Environment, Interdisciplinary Ecology Program, University of Florida, 103 Black Hall, Gainesville, FL 32611-6455, USA. **Peter Hildebrand** is Acting Director, International Programs-IFAS and Professor in the Department of Food and Resource Economics, University of Florida, PO Box 110240 IFAS, Gainesville FL 32611-0410, USA. **Christina Gladwin** is Professor, Department of Food and Resource Economics, University of Florida, PO Box 110240 IFAS, Gainesville, FL 32611-0410, USA. The authors are grateful for the patience and hospitality of farmers interviewed in Kasungu, Malawi, and for the help of the Rockefeller Foundation and the "Gender and Soil Fertility in Africa" project funded by USAID Soils CRSP. All errors and omissions are the responsibilities of the authors.

http://www.africa.ufl.edu/asq/v6/v6i1-2a11.pdf

ISSN: 2152-2448

agroforestry has the potential to improve soil fertility through the maintenance or increase of soil organic matter and biological N_2 fixing from nitrogen fixing tree species. [2] Agroforestry also protects the soil from eroding, thereby improving the soil's productive potential. Some woody species also provide diversified outputs for smallholder farmers in the form of fuelwood and poles. In some cases, agroforestry technologies such as fruit trees can provide a more diverse farm income and reduce food insecurity. Nair [3] and Young [4] have detailed the benefits of agroforestry.

The problem of soil fertility has been exacerbated by institutional constraints such as structural adjustment programs required by the World Bank and other donors. The impact of these "reforms" on food security in Malawi and other African countries has been a reduction in the use of chemical fertilizers that were commonly used by farmers to replenish soil fertility. Fertilizer prices have risen sharply in Malawi since the removal of fertilizer subsidies during the time period from 1986 to 1995. [5] Farmers are able to purchase very little fertilizer, if any at all. Most affected are women farmers, who account for over 70% of the food production group in Malawi [6] and who grow most of the subsistence food crops.

Recently, researchers in southern and eastern Africa have reported on the use of improved fallows as a means to return nutrients to the soil in a short period of time (e.g., nine months in Kenya with two rainy seasons to two years in eastern Zambia and Malawi with one rainy season). [7] Short duration rotations of managed fallows of sesbania [*Sesbania sesban* (L) Merr.], tephrosia [*Tephrosia vogelii*], and gliricidia [*Gliricidia sepium*] have the potential to replenish soil fertility and thereby increase crop yields of subsequent crops. [8] Consequently, these fallows are being promoted at many sites throughout the tropics, [9] due to their ability to improve soil fertility. However, experiences of agroforestry adoption show that in some cases agroforestry adoption has generally been low. [10] Furthermore, only recently has some attention been given to socioeconomic studies relating to agroforestry adoption. [11] Agroforestry research to date has predominantly focused on the biophysical aspects, with attention given mainly to yield benefits from researcher-managed agroforestry plots. In most cases, comparisons are made only on the maize yield benefits from agroforestry technology, which disregard the farmer's overall loss in maize production by planting part of the farm with trees.

To promote and increase the adoption of improved fallows as a sustainable method to increase food production and environmental protection, both researchers and development workers should understand the nature of limited-resource family farms. First of all, these farms are not businesses, but homes where diversity is a necessity. [12] Their major production goal is to secure sufficient food supplies for their families. They pursue diverse food procurement strategies in order to first satisfy home needs, and then sell any surpluses.

The different strategies pursued by farmers have significant implications for the types of technologies they are able to adopt. For example, the introduction of a new technology, such as an agroforestry innovation, may require fundamental changes in the way farm families approach their farming methods. Hildebrand has argued that researchers report on averages, which often misrepresent limited-resource farmers' real situations. [13] The rationale for this argument is that averages have little meaning in limited-resource family-farm households, who are so risk-averse that they base their expectations on a worst-case scenario of a bad-weather year, not on an "average year." Researchers who assume farmers expect average yields may therefore find their models do not predict the reality of the small, limited-resource farm. Due to this misunderstanding of resource–limited farms, researchers and extension workers often wrongly conclude that farmers are ungrateful laggards when they do not adopt agricultural technologies. [14]

In order to increase acceptability and promote wider adoption of improved fallows by resource-poor farmers, it is important to identify and analyze factors that affect the technology's adoptability for farm households with differing characteristics such as household composition and gender of the household head. [15] Gender of the household head plays an important role in the productivity of smallholder farming systems. Differences in the household's access to land and labor resources, financial and commodity markets, significantly influence cultivated land size, kind of crops planted, and farm income. [16] Relatively, African women farmers get lower crop yields than men; [17] but this is due to differences in the intensity of input use such as inorganic fertilizers, labor, credit, and extension education. [18] Given the same resources, Adesina and Djato found no differences in the efficiency of men and women in African agriculture and concluded that women are equally good farm managers as men. [19] When women have control over resources, however, they tend to use them differently than men, often spending more on their children, with different results for the welfare of the household. [20] Their choice of cropping activities is therefore different from that of the males, and tends to focus on food rather than cash crops. A deeper understanding of household decision-making will thus help policy makers and technology developers target individuals in the most effective way.

Gender also plays a role in the adoption of agroforestry technologies. Previous studies of adoption of improved fallow technologies in eastern Zambia show that female headed households are more likely to adopt improved fallows than are male headed households, holding constant other factors such as household size, previous experience with natural fallows, age and club membership of the household head. [21] It remains to be seen, however, whether or not this will also be the case in other, more populated regions of sub-Saharan Africa where improved fallow technologies are now being tested and promoted.

BACKGROUND TO IMPROVED FALLOWS IN MALAWI

The improved fallow technology in Malawi was introduced in 1997 after ICRAF initiated farmer-to-farmer contact with early adopters of improved fallows in eastern Zambia. In November of 1997, 18 farmers from Kasungu crossed the border into eastern Zambia, where farmers are at an advanced stage in the testing of improved fallows, and were given hands-on training on the planting and management of improved fallows of sesbania, tephrosia, and gliricidia tree species. Reportedly, they returned to Malawi determined to plant their own improved fallows trial plots. [22]

Unlike the southern part of Malawi, smallholder land holdings in Kasungu are slightly higher than the national average. Table 1 shows that in Kasungu ADD in the 1992/93 season, only 34% of plots (called gardens in Malawi) were less than 1 hectare; while almost 43% of gardens were between 1 and 1.99 hectares and 23% were at least 2 hectares. [23] Therefore, land availability is adequate in Kasungu when compared to southern Malawi. In fact, ICRAF introduced the improved fallow technology in Kasungu because farmers there have relatively more land than average in Malawi. In addition, the improved fallow technology is targeted at those farmers with large landholdings. Because we drew our sample from the ICRAF list of testers of the technology, the sample of farmers chosen for this study also have larger-than-average landholdings for Kasungu.

Table 1. Land holding sizes in Malawi by Agricultural Development Division (ADD)

Agric Dev. Div.	Total Est. Gardens (number)	---------Holding size by Category (%)-------		
		<1.00 ha	1.00-1.99 ha	2.00 ha & over
All Malawi	2738607	67.6	24.3	8.1
Karonga	132493	73.5	23.7	2.8
Mzuzu	238820	51.0	32.2	16.8
Kasungu	305598	33.7	43.6	22.7
Salima	153812	69.2	23.0	7.8
Lilongwe	487285	64.8	27.0	8.2
Machinga	610613	72.7	23.3	4.0
Blantyre	646718	86.8	11.6	1.6
Shire Valley	163268	62.5	23.3	13.7

Source: National Sample Survey of agriculture 1992/93 Volume II

This paper evaluates the potential of adopting improved fallows by the Kasungu farmers who are now testing improved fallows. Ethnographic linear programming (ELP) is used to assess whether adoption of improved fallows is feasible and economically viable for these smallholder farmers, given their agro-climatic and socioeconomic conditions. The next section of the paper gives the description of the study area and an outline of the study methodology. It also establishes the modeling framework and details the main resource constraints included in the model, and describes the results and discussion.

METHODOLOGY

The research was conducted in Kasungu (13° 1' 60S, 33° 28' 60E), central Malawi, in the Kasungu Agricultural Development Division (KADD) agroecosystem. Kasungu district covers 14% of the country and contains 11% of the country's total rural population covering four administrative districts of Kasungu, Dowa East, Ntchisi, and Mchinji. Kasungu experiences a warm tropical climate characterized by a unimodal rainfall pattern with a wet season of approximately five months, running from November/ December to March/April with erratic rains ranging from 500 to 1200 mm per year and a prolonged dry season for the rest of the year. The town of Kasungu lies at an altitude of 1342 meters and has a mean annual temperature of 19-22.5°C. The soils are predominant oxisols, ultisols, and alfisols (USDA taxonomy). [24] Specifically, the study was conducted in two extension-planning areas (EPAs), Chulu (13° 40' 60S, 33° 40' 0E) lying at 1211 meters above sea level and Kasungu–Chipala (13° 0' 0S, 33° 28' 60E) at 1151 meters above sea level (Figure 1).

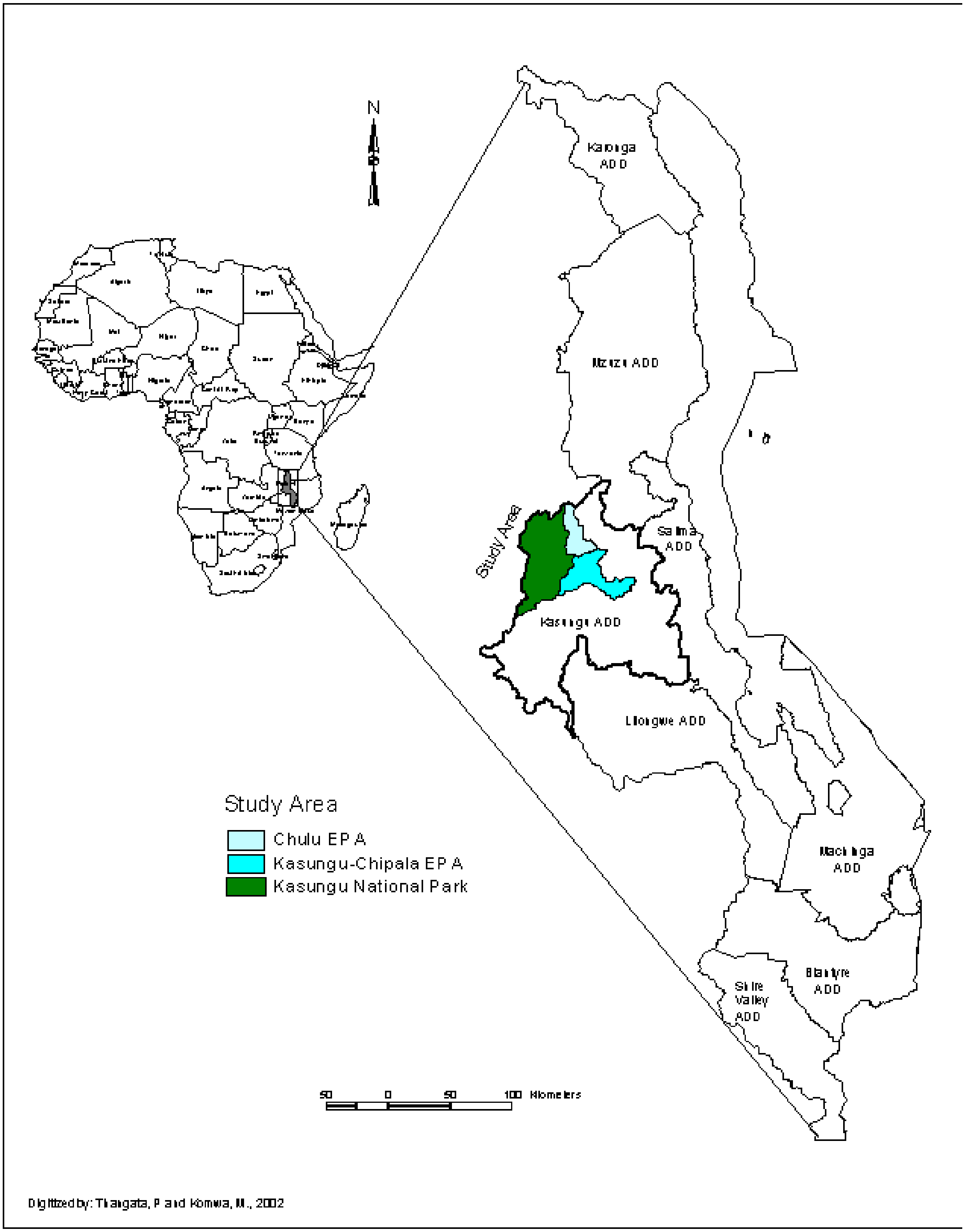


Figure 1. Study area.

DEMOGRAPHICS AND ECONOMIC ACTVITIES

Kasungu has a population of 476,000 people (about 51.5% are male). Of the total district population, 52% of the people are under 18 years old. [25] Most of the people in the rural areas of Kasungu are farmers. About 52% of the women in the area are involved in farming activities (Table 2).

Table 2. People aged 10 years and over and the economic activities by gender in Kasungu.

Economic Activity	Male	Female
Total	169,451	154,452
Economically active	118,502	95,566
Total Working	117,601	95,156
Farmer	79,384	84,505
Employee	29,835	7,621
Family business worker	2,350	1,294
Self-employed	5,624	1,694
Employer	408	42
Total Unemployed	901	410
Worked before, seek work	243	127
Worked before, not seeking	150	50
Never worked, seeking	508	233
Not economically active	50,949	58,886
Never worked, not seeking	1,349	1,389
Homeworker	1,344	17,420
Student	47,049	38,758
Other	1,207	1,319

Source: National Statistical Office (1998) Malawi Population and Housing Census.

Crop Production

The major crops grown by all farmers in the area are maize (*Zea mays* L), tobacco (*Nicotiana tabacum* L.), the main cash crop, and groundnuts (*Arachis hypogaea* L.). In Kasungu, maize production occupies 70% of the cultivated area, followed by groundnuts (12%), and tobacco (3-10%). Crop rotation is a requirement for tobacco producers in order to reduce disease/ pest infestation. Groundnuts are important in the farming system. [26] Due to low producer prices, however, groundnut production has decreased in recent years. Minor crops include cassava and sweet potatoes. Some beans and/or bambara nuts are planted as intercrops with maize. Vegetables are grown in the wetland areas (dambos), mostly during the dry season. However, most of the wetland areas are used for tobacco nurseries.

Tobacco is given the first priority together with maize, followed by groundnuts. Tobacco is sown in nurseries and transplanted from October to December or early January. Minae and Msuku [27] report that planting of the tobacco nursery starts early, around July-August. Field preparation starts soon after harvesting in April, but not on all farms. Tobacco and maize fields are prepared first and made ready for planting when rains come. Peak labor periods are September to December. Planting depends on the start of the rains, amount of rainfall and distribution (mostly October/ November). Tobacco can be dry planted in December as long as farmers are sure of rainfall within two to four weeks. Weeding requires large amounts of labor and is done from December to February or when weeds appear for all crops. Towards the end of February, farmers who plant early can start harvesting tobacco. In most cases, cassava and sweet potatoes are planted during land preparation.

The family is the main source of labor, although some households that can manage do hire labor. Communal labor is common at maize harvest but not at tobacco harvest. Men sometimes help each other in grading and baling tobacco. There is a very limited use of ox-plows, but the majority of farmers use hand tools. The farmers in this study consider hiring equipment too expensive.

Data Collection

Data collection in this study occurred between September and December 1999 and again between June and August 2001. Primary data collected in 1999 involved household surveys, participatory rural appraisals (PRA), and informal interviews to produce data for the ethnographic linear programming (ELP) models. First, meetings were held with extension workers. Group meetings followed with farmers from the two areas, Chulu and Kasungu–Chipala. Later, using structured and semi-structured questionnaires, detailed formal interviews were conducted with ten households, randomly sampled from the extension agent's list of testers of the technology. Different households were selected so that they could eventually serve as representations of different recommendation domains. [28] Secondary data, such as yield data, were gathered from ICRAF, the Malawi Agroforestry Extension Project (MAFE), and the Kasungu Agricultural Development Division. The first author conducted all the interviews, but the third author also later visited some of the households. Ethnographic linear programming (ELP) models were developed for each of the ten households interviewed. Two representative households are reported in this paper.

In 2001, the ten households interviewed in 1999 were re-visited to test the models' prediction ability, and to validate and check areas where the models needed improvements. Discussions were held with farmers to see whether the models' preliminary output results adequately depicted what they produce and how. Another 31 farmers were interviewed to ascertain the labor data and to check how well the models selected from the households interviewed in 1999 represent the community by comparing the household compositions, labor availability, and food requirements.

MODEL FRAMEWORK

The model is a ten-year, dynamic linear programming model. The matrix of technical coefficients is identical for all households, but the resource endowments change with each new household solved in the model. The model maximizes an objective function, e.g., household income or food production, subject to constraints on the household, such as cash, labor and land, after meeting home consumption requirements. The ELP models used in this study are ethnographic in nature, meaning that specification of the objective function and constraints in this model were determined based on interview data from the Kasungu farmers.

Ethnographic linear programming (ELP) simulates the farmers' strategies by choosing between different alternative livelihood activities available to farmers in the region and representing different degrees of crop intensity, labor, and land saving techniques available. It takes into account their respective costs, constraints, and advantages, as they report them. It is an adaptation of linear programming that Hildebrand and others at the University of Florida have developed. [29] ELPs are a means of quantifying ethnographic data, mostly qualitative, and are thus both descriptive and analytic. By modeling all the activities of and constraints on the farming household, they help researchers understand the complexity and diversity of smallholder farming systems.

The objective function in the ELP is represented by the general format:

$$\textit{Maximize } Z = cx$$

subject to

$$Ax \leq b$$
$$x \geq 0$$

where Z in this model is the discretionary cash income farmers have at the end of the year after using their constrained resources (represented by the rows of the matrix) to engage in different livelihood activities (represented by the columns of the matrix). C is the row vector of enterprise year-end cash, x is a column vector of enterprise levels (and all x's are equal to or greater than zero), A is a matrix of technical coefficients, and b is a column vector of farm resource endowments or consumption requirements on the right hand side of the inequality sign. The rows of the matrix also represent the constraints farming households operate under; for example, they must meet necessary cash expenses and provide food security in the household given their resources such as land, labor and cash (b). The consumption constraints in the model reflect the need for the households to first satisfy household food requirements before marketing any surplus. To specify consumption constraints, minimum food requirements for the household are specified for each crop. The particular model size reflects the detailed specification of the relationships of different activities being represented. The model was implemented in MS Excel® [30] spreadsheet. MS Microsoft Visual Basic® 2000 [31] was used to make calling and solving different households easy and flexible. The premium add-in solver [32] for Excel was used to handle the large number of variables.

Assumptions of the Model with Respect to Production Activities

The model makes certain assumptions about smallholder production, based on farmer reports. For example, crops in Kasungu are assumed to be monocrops. They include maize, the staple food; tobacco, the cash crop; and sweet potatoes, cassava, and groundnuts. Improved fallows of sesbania and tephrosia are considered as alternative cropping activities that can be planted every year and thus are also represented by columns in the matrix. Maize is produced either fertilized or non-fertilized, or following a two-year improved fallow of sesbania or tephrosia. Because the improved fallow trees can be planted every year, maize can be planted after the fallow plots every year after the second year. Tobacco, the main cash crop, is never planted after the fallow trees, because both sesbania and tephrosia are hosts to root knot nematode, and tobacco is susceptible to nematode attack. Due to storage and marketing problems, the model also limits the production of sweet potatoes and cassava to 0.25 and 0.33 hectares respectively. Minimum food requirements used in the model are presented in Table 3. The data used in the model (e.g., total input costs for each cropping activity, yield and price data for each activity), are presented in the bottom rows of Table 4.

Table 3. Minimum food requirements for a household for each crop in kilograms per year.

Crops	---------Food Requirements (kg/year)-------		
	Adult	Child	Infant (<5 years)
Maize	250	150	50
Cassava	70	35	35
Sweet potato	70	35	35
Groundnut	100	50	50

RESOURCE CONSTRAINTS IN THE MODEL

The model also makes certain assumptions about the limits to farmers' use of cash and agricultural input credit. Most households have limited cash available to them; the total amount of cash inputs available is enough for one hectare of purchased fertilizer, seed, nursery chemicals, and transportation to the auction floors in the case of tobacco. Farmers who plant tobacco also have access to credit. Women farmers, especially FHHs, split the fertilizer received on credit for tobacco and apply a portion of it on their maize crop. In 1999/2000, the interest rate for loans was 55%. The model also allows for cash to be transferred from one year to the next to be used for purchasing agricultural inputs.

Labor Assumptions

Similarly, the model makes assumptions about farmers' use of labor, again based on farmer reports. The labor data used in the model (in labor-person days) for each activity are presented in the top rows of Table 4. It is assumed that each adult male or female in the household provides 25 labor days in a month. Because the harvesting of tobacco is quite labor demanding, households may hire additional labor from outside the region and pay them a lump sum payment at the end of the season after tobacco sales. This is in contrast to maize, for which additional labor demands can be met by communal labor.

The model separates out labor inputs by gender and by month; and labor supply in any calendar month is the total amount of labor available from the contribution of all household members and hired labor. Because women are responsible for childcare, the number of infants (under 5 years old) reduces the female labor contribution to production in a household. Therefore, labor from a female with an infant is reduced from the 25 labor days available in a month to 22 labor days, due to childcare activities. Most cropping activities are done either by men or women. Males, however, are responsible for most of the tobacco activities; while groundnut production and maize transportation are mostly a woman's job. For school-going adolescents, labor contributions vary, depending on whether they live at home during the school year. As the children in the household grow, they also contribute more labor (and require more food), and the data in the model reflect these changes.

Table 4. Summary of crop activities, income and resource use for production activities on a per hectare basis as used in the matrix.

Crop activity	TBCCO		FERT MZE		NF MZE		SS I	SS II	TV I	TV II	SS MZEI	TV MZE I	GNUT		CSVA	SWPOT
Labor-P/dys	M	F	M	F	M	F							M	F		
September	50	12	7	7	7	7	5	-	5	-	19	5	14	14	5	5
October	25	25	10	10	10	10	24	-	25	-	15	25	11	11	6	6
November	25	25	20	20	20	20	19	-	10	-	12	10	5	11	9	9
December	30	30	11	11	11	11	32	-	23	-	22	23	8	8	6	6
January	18	18	11	11	11	11	39	10	5	-	19	5	15	20	9	9
February	29	29	12	12	12	12	10	10	-	7	9	-	11	11	9	9
March	49	30	5	5	5	5	-	-	7	7	5	7	20	40	6	6
April	63	30	-	-	-	-	-	-	7	-	12	7	20	40	5	5
May	57	30	7	7	7	7	-	-	-	-	11	-	20	40	5	5
June	20	20	5	5	5	5	-	-	-	-	9	-	12	22	5	5
July	27	10	2	2	2	2	-	-	-	-	5	-	-	-	5	5
August	27	10	2	2	2	2	-	-	-	-	3	-	-	-	2	2
Inputs (US$)	170.30		98.22		18.47						18.47	18.47	51.82			
Yield (kg/ha)	700		**4250**		800		180	530	145	335	**3930**	**2913**	800		**2500**	**2500**
Year II	-		-		-		-	-	-	-	**3000**	**2850**	-			-
Year III	-		-		-		-	-	-	-	**2850**	**2375**	-		-	-
Selling Price ($/Kg)	1.10		0.09		0.09		1.04	0.79	1.04	0.79	**0.09**	**0.09**	0.49		0.15	0.15

Crop key: M, F = Male, Female; TBCO=Tobacco; FERTMZE=Fertilized maize; NFMZE=Unfertilized maize; SS= Sesbania fallow; TV= tephrosia fallow; SSMZE= Maize following a sesbania fallow; TVMZE=Maize following a tephrosia fallow; GNUT=groundnut; CSVA=Cassava; SWPOT=Sweet potato; Inputs=amount of cash required to purchase fertilizers, chemicals, seed etc

MODELING GENDER DIFFERENCES

To model gender differences, two representative households, a male-headed household (MHH) and a female-headed household (FHH) were simulated. The MHH is composed of one adult male, one adult female and two boys in the 6-10 age group. The FHH has one adult female and four adolescent children, three girls of school age (11-14) and one younger girl, under 10 years old. The MHH is assumed to have 2.12 ha of land (the median land size of the 32 MHHs in this sample); while the FHH has 2.55 ha of land (the median land size of the eight FHHs in this sample). [33] The households have the option to take credit in the form of farm inputs, and both households have the option to hire labor.

At the initial stage of diffusion of improved fallow technologies, ICRAF and other NGOs were buying seeds from sesbania and tephrosia to give to other farmers. Sales of tree seeds amount to a windfall profit for early adopters and a monetary incentive to adopt improved fallow technologies for late adopters. This was a temporary benefit, which has almost stopped. To evaluate whether this additional income from improved-fallow seeds enhances adoption, and to test under what conditions farmers adopt improved fallow technologies, we test two scenarios. In scenario 1, farmers do not sell sesbania or tephrosia seeds; in scenario 2, there is a market for the seeds. In both scenarios, we run simulations with all crops and both fallow species, and solve for the optimal resource allocation, and see if farmers adopt improved fallow technologies. The only difference between scenarios 1 and 2 is that scenario 2 allows the households to engage in selling sesbania and tephrosia seed both to their neighbors and ICRAF personnel.

RESULTS AND DISCUSSION

In dynamic modeling, we start the first season with an arbitrary amount of cash available in the model. therefore the first year is not representative. Starting from year 1, cash can be transferred to the following season. From experience the arbitrary amount can also affect the second year. By the third year, this effect disappears. therefore, the first two years are not reported in this study.

End-of-planning-horizon effects have to be taken into account. These are situations whereby the model chopsoff the analysis at some finite time in the future. Because there is no future in the model in the last years of the dynamic program, it can see no benefits from certain activities in those years (such as livestock production or multi-year agroforestry trials), and so it eliminates those activities from the "optimal solution" in the last years of the program.

Because improved fallows planted in the 9th and 10th year do not yield any benefits until after the 10th year, when the model has ended, the model chooses only those activities that are of benefit to the farm in the 9th and 10th year and thus drops agroforestry activities from the simulated results in those last two years. To reflect the above dynamic , only results from years three to eight are reported.

Scenario 1. Simulations without seed selling activity in the male-headed household (MHH)

Table 5 summarizes the results of the MHH without the seed selling activity. Without the option of selling improved fallow seeds, the results show the MHH plants over half a hectare of improved fallows in all years, with more sesbania planted than tephrosia. This is despite the fact that sesbania establishment requires nursery management like tobacco and hence requires more labor. This can be due to the fact that although tephrosia is directly seeded like maize and therefore needs less labor, the maize yield following the sesbania fallows is greater than after tephrosia. As a result, there is a slow but steady expansion of land under sesbania fallow.

The household plants similar amounts of tobacco and groundnuts and sufficient cassava or sweet potatoes to satisfy consumption requirements. No labor is employed and family members do all the work. The household uses less total land than available in all years and a tobacco loan is taken in each year, but it is unable to keep any cash for future use and there is no discretionary cash income. [34]

Table 5. Simulated crop production (ha) activities for MHH without seed selling

Activities	-----------------------------------Year-----------------------------------					
	3	4	5	6	7	8
Production (ha)						
New Sesbania	0.23	0.36	0.20	0.40	0.38	0.36
New Tephrosia	0.10	0.10	0.10	0.10	0.10	0.10
Old Sesbania	0.15	0.23	0.36	0.20	0.34	0.38
Old Tephrosia	0.10	0.10	0.10	0.10	0.10	0.10
Fert. Maize	0.00	0.00	0.00	0.00	0.00	0.00
IF Maize	0.25	0.25	0.33	0.44	0.30	0.44
New IF	0.33	0.46	0.30	0.50	0.48	0.46
Year Old IF	0.25	0.33	0.46	0.30	0.44	0.48
Total IF	0.58	0.79	0.76	0.80	0.92	0.94
Tobacco	0.09	0.09	0.09	0.09	0.09	0.09
Groundnut	0.07	0.07	0.09	0.10	0.10	0.10
Cassava	0.02	0.02	0.03	0.04	0.04	0.04
Sweet potato	0.02	0.02	0.03	0.04	0.04	0.04
Total land	1.03	1.24	1.33	1.51	1.49	1.65
Selling (kg)						
Tobacco	61	61	63	65	66	65
Cash (US$)						
Loan	21	21	24	27	28	27
End Year Cash	0	0	0	0	0	0

In all years, all the maize for home consumption comes from land previously in improved fallows and, starting from the 6th year, there is an increase (in fact, a doubling) in the amount of land planted to maize from improved fallow land. This increase could be due to the increased food requirements and labor contribution from the children in the household as they age. In our judgment, however, the expansion of maize production is caused by the large decrease in the costs of growing maize with improved fallow technologies. As the input-costs row of Table 4 shows, it is cheaper to grow maize with the improved fallow technologies (US$ 18.5) rather than with purchased inorganic fertilizers (US$ 98). As a result, the model predicts farmers expand their improved fallow plots and maize plantings in those plots, and grow *no* maize planted with expensive inorganic fertilizers.

Scenario 1. Simulations without seed selling activity in the female-headed household (FHH)

Results show the FHH adopts improved fallows as the MHH; she plants at least half a hectare of sesbania fallow in five of the six years of the time period, along with 0.2 ha of tephrosia fallow. This result is in line with those reported by Gladwin et al. [35] from eastern Zambia that FHHs adopt improved fallow technologies; and is not surprising, given the larger farm size of the small sample of FHHs in this study. Indeed, it is only surprising because to date FHHs in eastern Zambia have planted only very small plots of improved fallows and are struggling to plant plots of one-fourth a hectare.

Table 6. Simulated crop production (ha) activities for FHH without a seed selling activity.

Activities	------------------------------------Year----------------------------------					
	3	4	5	6	7	8
Production (ha)						
New Sesbania	0.24	0.26	0.26	0.29	0.33	0.28
New Tephrosia	0.10	0.10	0.10	0.10	0.10	0.11
Old Sesbania	0.31	0.24	0.26	0.26	0.29	0.33
Old Tephrosia	0.10	0.10	0.10	0.10	0.10	0.10
Fert. Maize	0.00	0.00	0.00	0.00	0.00	0.00
IF Maize	0.39	0.41	0.34	0.36	0.36	0.39
New IF	0.34	0.34	0.36	0.39	0.43	0.39
Year Old IF	0.41	0.34	0.36	0.36	0.39	0.43
Total IF	0.75	0.68	0.72	0.75	0.82	0.82
Tobacco	0.06	0.19	0.07	0.08	0.08	0.09
Groundnut	0.09	0.09	0.09	0.09	0.09	0.09
Cassava	0.03	0.03	0.03	0.03	0.03	0.03
Sweet potato	0.03	0.03	0.03	0.03	0.03	0.03

Total land	1.35	1.45	1.33	1.34	1.41	1.42
Selling (kg)						
Tobacco	44.3	133.7	51.2	55.4	59.3	64.8
Cash (US$)						
Loan	20.4	42.5	21.2	22.5	23.5	26.5
End Year Cash	0	0	0	0	0	0

Like the MHH, the FHH plants simular amounts of tobacco and groundnuts. However, since tobacco requires more labor, the FHH hires male labor. The hired labor has to be fed daily, as well as paid at the end of the season. Therefore, hired labor results in the need to plant more maize. The need for cash for home use dictates that they grow tobacco, which requires a loan, and the hired labor increases the maize consumption requirements.

A comparison of Tables 5 and 6 show both households plant tobacco, probably since it is their only source of income. Without any other source of cash, the households need to grow tobacco and take tobacco loans with an interest rate of 55%. Although the MHH may employ labor, the model opts not to, because there is enough family labor.

Scenario 2. Simulations with a seed selling activity-MHH

Table 7. Simulated crop production (ha) and selling activities for MHH with a seed selling activity.

Activities	--------------------------------Year------------------------------------					
	3	4	5	6	7	8
Production (ha)						
New Sesbania	0.12	0.12	0.12	0.19	0.23	0.21
New Tephrosia	0.10	0.10	0.10	0.10	0.11	0.12
Old Sesbania	0.13	0.12	0.12	0.12	0.19	0.23
Old Tephrosia	0.16	0.10	0.10	0.10	0.10	0.11
Fert. Maize	0.00	0.23	0.10	0.36	0.21	0.13
IF Maize	0.39	0.23	0.22	0.22	0.22	0.29
New IF	0.22	0.22	0.22	0.29	0.34	0.32
Year Old IF	0.30	0.22	0.22	0.22	0.29	0.34
Total IF	0.52	0.44	0.44	0.51	0.63	0.66

Tobacco	0.19	0.22	0.20	0.30	0.33	0.31
Groundnut	0.11	0.12	0.09	0.15	0.10	0.10
Cassava	0.33	0.33	0.33	0.33	0.33	0.33
Sweet potato	0.25	0.25	0.25	0.25	0.25	0.25
Total land	1.80	1.83	1.62	2.12	2.07	2.09
Selling (kg)						
Tobacco	136	156	137	210	230	219
Maize	566	923	0	672	0	0
Groundnut	51	52	0	52	0	0
Cassava	765	765	750	735	735	735
Sweet potato	565	565	550	535	535	535
Sesbania seed	253	159	151	162	207	264
Tephrosia seed	114	92	92	92	94	97
Cash (US$)						
Loan	0	0	0	0	0	0
Cash Transfer	68	50	94	83	75	92
End Year Cash	510	412	244	303	256	219

When an improved fallow seed-selling activity is introduced as an incentive to adopt the improved fallow technology, the MHH grows more tobacco than in scenario 1, but does not take a loan. Ccash from selling sesbania and tephrosia seeds results in the households having enough cash without the need to take loans for their tobacco.

When compared to scenario 1, there is an increase in the total land used, but a decrease in the total land planted to improved fallows. Because the household does not take any loans, it produces more tobacco using the cash from the seed selling activity, grows some fertilized maize, and sells surplus maize. The MHH has discretionary cash at the end of the season, and the household is able to transfer some cash for subsequent years. The MHH does not need to pay for hired labor costs, and therefore produces maize, groundnuts, cassava, and sweet potato for sale to cover cash needs.

Scenario 2: Simulations with a seed-selling activity in a FHH

With the additional option of selling improved-fallow seeds (to ICRAF or to neighbors), the FHH plants even more land to improved fallows (e.g., 0.7 ha of sesbania in year 3). The FHH also plants more improved fallows than the MHH, as was the case in scenario 1 (Tables 4 and 6). However, she gradually reduces the land planted in sesbania fallows from 0.7 ha in year 3 to 0.5 ha in years 4 and 5 to 0.3 ha in years 7 and 8.

This household also plants more maize following improved fallows in year 3, but gradually reduces land in maize following an improved fallow in latter years. As improved fallow land decreases, the household also plants less and less “improved-fallow maize” and even fertilizes maize (0.1 ha) in years 5, 7 and 8. The household has surplus maize for sale in years 3, 4 and 6. It also increases land for tobacco production, probably due to the windfall profits from the seed selling activity, but also maintains groundnut production as in scenario 1. Due to the sales of sesbania and tephrosia seeds as well as sales of tobacco, the FHH has more end year cash than the MHH. This is probably due, however, to the larger land size of FHHs in this sample.

Table 8. Simulated crop production (ha) and selling activities for FHH with a seed selling activity.

Activities	---------------------------------Year-------------------------------------					
	3	4	5	6	7	8
Production (ha)						
New Sesbania	0.10	0.39	0.10	0.10	0.17	0.14
New Tephrosia	0.10	0.10	0.21	0.10	0.10	0.10
Old Sesbania	0.55	0.10	0.39	0.10	0.10	0.17
Old Tephrosia	0.10	0.10	0.10	0.21	0.10	0.10
Fert. Maize	0.00	0.00	0.13	0.00	0.15	0.18
IF Maize	0.62	0.65	0.20	0.45	0.20	0.20
New IF	0.20	0.49	0.31	0.20	0.27	0.25
Year Old IF	0.65	0.20	0.49	0.31	0.20	0.27
Total IF	0.85	0.69	0.80	0.51	0.47	0.52
	0.93	0.56	0.24	0.17	0.23	0.25
Tobacco	0.09	0.09	0.09	0.14	0.11	0.09
Groundnut	0.03	0.31	0.29	0.33	0.33	0.33
Cassava	0.03	0.25	0.25	0.25	0.25	0.25
Sweet potato	0.93	0.56	0.24	0.17	0.23	0.25
Total land	2.55	2.55	2.00	1.85	1.74	1.81
Selling (kg)						
Tobacco	650	394	167	116	164	173
Maize	566	923	0	672	0	0
Groundnut	0	0	0	62	25	0
Cassava	0	701	648	750	750	750

Sweet potato	0	550	550	550	550	550
Sesbania seed	597	425	278	263	138	168
Tephrosia seed	92	92	108	129	93	93
Cash (US$)						
Loan	0	0	0	0	0	0
Cash Transfer	110	60	40	61	66	77
End Year Cash	1304	751	370	289	198	171

With a seed selling incentive, the FHH generates enough cash from selling sesbania and tephrosia seeds, and therefore no longer takes a tobacco loan. As a result, Table 8 shows that land allocated to tobacco is increased substantially in the third and fourth year. Unlike the MHH, the FHH grows less fertilized maize, but also grows other crops like groundnut, cassava and sweet potatoes following the MHH trend. The FHH maintains a production of 0.1 ha of groundnut. The household transfers cash to be used in the next season.

Conclusions

This study predicts that where sufficient land is available as in Kasungu, Malawi, adoption of improved fallow technologies will occur. Farmers with access to land and a productive labor force are going to adopt improved fallows, with or without the extra incentive of also being able to sell the tree seeds back to those promoting the technology (e.g., ICRAF or other NGOs). With the seed-selling activity available, however, adopters of improved fallows expand the size of their improved fallow plots, as well as the amount of maize they produce. They may then produce a surplus of maize and increase the size of land planted to the cash crop, tobacco. Success may come at a price, however, as they can then afford to buy some fertilizer, and will in that case plant some fertilized maize and eventually decrease the amount of land planted to improved fallows.

With hired labor labor FHHs are able to plant more land to improved fallows, in year three, than MHHs. This same result, however, may not hold in other regions of Africa where FHHs have less land than MHHs, and less access to labor. Land holdings in Kasungu are relatively larger than in southern and some of the other districts in central Malawi and therefore, these findings might not be generalizable to areas where land holdings are small. Another point to consider is the source of cash in a farming system. In Kasungu, tobacco is the only cash crop and assuming there were other cash crops requiring less labor, these results would likely be different. With this is in mind we concur with Sullivan (in this volume) [36] and Gladwin et al. [37] who suggest that researchers should disaggregate households by household composition as well as by gender, and target new technologies at subgroups of rural women. This is because small scale farmers are not all alike, and will not respond equally to a technological intervention. This also applies to agroforestry innovations. The results of this study therefore specifically deal with Kasungu and not the whole of Malawi. Apart from land constraints, in order to evaluate the adoptability of agroforestry technologies, it is necessary to determine the availability of labor in the household, which is an important factor in the degree of adoptability of improved fallows.

It can also be concluded that farmers plant tobacco as a way of getting inorganic fertilizers for their maize. They raise enough tobacco to be able to repay the loan and to pay for hired labor. A high price from sales of tree seeds might encourage farmers to plant less tobacco and more improved fallows. Those households with enough labor and land are likely adopters. As observed in this study, when seed selling was introduced, the FHH stopped taking a tobacco loan.

Our analysis shows that in Kasungu, FHHs without adolescent male children employ male labor for the tobacco growing activities, most of which are done by males. In FHHs where there are male adolescents, the male children take the role of a male head in these households, and provide labor for work demanded by crops like tobacco. This allows FHHs to spend their time planting improved fallows rather than tobacco during the rainy season, in addition to other women's tasks such as fetching water, firewood collection, cooking and childrearing. It appears that in Malawi, adoption of improved fallows can happen in both MHHs and FHHs, as long as land and labor available.

Notes

1. Nye and Greenland, 1960
2. Nair,1993
3. Nair,1993
4. Young, 1997
5. Gladwin 1991; Zeller et al., 1998
6. Quisumbing et al., 1995
7. Kwesiga and Beniest, 1999; Jama et al., 1998.
8. Kwesiga, et.al., 1999; Sanchez, 1999
9. Franzel, 1999; Sanchez 1999
10. ICRAF, 1997
11. Kwesiga, et. al., 1999; Franzel, 1999; Franzel, et al., 2001; Gladwin et al., 2001; Gladwin, et al., 2002
12. Hildebrand, 2000a
13. Hildebrand, 2000b
14. Hildebrand, 2000c
15. Franzel, 1999
16. Due et al., 1983; Due and Gladwin, 1991; Quisumbing, 1996
17. Quisumbing, 1995
18. Quisumbing, 1996
19. Adesina and Djato, 1997
20. Frankenberger and Coyle, 1992
21. Gladwin, et al., 2002
22. ICRAF, 2002

23. NSSA, 1994; The NSSA has defined a garden as a small or large piece of land that might be continuous and one garden may have several different crops.
24. Young and Brown, 1962
25. NSO, 1998
26. Minae and Msuku, 1988
27. Minae and Msuku, 1988
28. Hildebrand and Russell, 1996
29. Cabrero,1999; Bastides,2000; Kaya et. al., 2000; Litow, 2000; Hildebrand, 2002c; Sullivan 2000; Mudhara, 2002; Thangata, 2002
30. MS Excel® 2000
31. MS Visual Basic® 2000
32. Frontline Systems, 2000
33. FHHs are slightly underrepresented in this sample of 40 farmers, as they usually comprise 25-35% of households in Malawi. Their surprisingly large land size, larger than that of MHHs, is probably due to the presence in this small sample of two FHHs who own 5 and 6 ha of land. Half of the FHHs in this sample owned and operated only 1.5 ha of land, which is more in line with other reports of mean land size in Kasungu (Gladwin 1987). Due to the small number of FHHs in this sample, however, their data could not be omitted. Hence, FHHs in this sample own and operate more land than the MHHs, in contradiction with the WID literature on FHHs. It is understandable, however, given that ICRAF extension personnel were purposefully looking for larger farmers to test the improved fallow technologies in Kasungu, and this sample came from their list of tester-adopters.
34. Grinold,1983; Schrage,1997
35. Gladwin, et al., 2002
36. Sullivan- this volume;
37. Gladwin et al., 2001

References

Abdulkadri, A.O., Ajibefun, I.A. "Developing alternative farm plans for cropping system decision making" *Agricultural Systems* 56, (1998): 431-442.

Adesina, A.A., Djato, K.K. Relative efficiency of women as farm managers: Profit function analysis in Cote d'Ivoire. *Agricultural Economics* 16, (1997): 47-53.

Bastidas, Elena P. "Assessing potential response to changes in the livelihood system of diverse, limited-resource farm households in Carchi, Ecuador : modeling livelihood strategies using participatory methods and linear programming." Ph.D. Diss., University of Florida, 2001.

Cabrera, V. "Farm problems, solutions, and extension programs for small farmers in Cañete, Lima, Peru." Master's thesis, University of Florida, 1999.

Due, J.M., Muyenda, T., and Miller, P. How do rural women perceive development? A case study in Zambia. Department of Agricultural Economics, University of Illinois, Urbana. Report 83-E-265. 1983.

Due, J.M, and Gladwin, C. "Impacts of Structural Adjustment Programs on African Women Farmers and Female-Headed Households." *American Journal of Agricultural Economics* (Dec*):* (1991): 1431-1439.

Frankenberger, T.R., Coyle, P.E. "Integrating household food security into farming systems research-extension." *Journal of Farming System Research-Extension* 4, (1992): 35-66.

Franzel, S. "Socioeconomic factors affecting the adoption potential of improved fallows in Africa." *Agricultural Systems* 4, (1999): 305-321.

Franzel, S., Coe, R., Cooper, P., Place, F., and Scherr, S.J. Assessing the adoption potential of agroforestry practices in sub-Saharan *Agricultural Systems,* 69 (2001). 37-62.

Frontline Systems. Premium solver for Excel for Windows, 1999.

Gladwin, C. H., (Ed.) *Structural Adjustment and African Women Farmers*, University of Florida Press, Gainesville, 1991.

Gladwin, C. "Gender impacts of fertilizer subsidy removal program in Malawi and Cameroon." *Agricultural Economics* 7, (1992): 141-153

Gladwin, C., Thomson, A.N., Peterson, J.S., and Anderson, AS. "Addressing food security in Africa via multiple strategies of women farmers." *Food Policy* 26, (2001): 177-207.

Gladwin, C., Peterson, J.S., and Mwale, A.C. "The quality of science in participatory research: A case study from Eastern Zambia," *World Development* (2002). Forthcoming.

Grinold, R.C. "Model building techniques for the correction of end effects in multistage convex programs." *Operations Research*, 31 (1983): 407-431.

Hildebrand, P.E. Technology for Small Farms: The Challenge of Diversity. Invited keynote address at the Workshop on No-till Farming in South Asia's Rice-Wheat System: Experiences from the Rice-Wheat Consortium and the USA, Ohio State University, February 2002. (2002a).

Hildebrand, P.E. Global Research Challenges. Including Smallholders in Rural Development. Invited keynote address at the 1st Henry A. Wallace Inter-American Scientific Conference on Globalization of Agricultural Research. CATIE, Turrialba, Costa Rica, February 25-27, 2002. (2002b).

Hildebrand, P.E. *Ethnographic Linear Programming: Modeling Resource-limited Family Farm Households.* Book (forthcoming). (2000c).

Hildebrand, P.E., Poey, F. *On-farm Agronomic Trials in Farming Systems Research and Extension.* Boulder, Colorado: Lynne Rienner Publishers, Inc, 1985.

Hildebrand, P.E., Russell, J.T. *Adaptability Analysis: a Method for the Design, Analysis and Interpretation of On-farm Research-Extension.* Ames Iowa: Iowa State University Press, 1996.

ICRAF. Annual Report 1996. International Center for Research in Agroforestry, Nairobi, Kenya, (1997).

ICRAF. Annual Report Highlight. International Center for Research in Agroforestry, Nairobi, Kenya. Accessed 6 July 2002 [http://www.icraf.cgiar.org/inform/CorpReport/Highlights2.pdf] (2002).

Jama, B., Buresh, R.J., and Place, F.M. Sesbania tree fallows on phosphorus-deficient sites: Maize yield and financial benefit. *Agronomy Journal* 90, (1998): 717-726.

Kaya, B., Hildebrand, P.E, Nair, P.K.R. "Modeling changes in farming Systems with the adoption of improved fallows in southern Mali." *Agricultural Systems* 66, (2000): 51-68.

Kwesiga, F., and Beniest, J. Sesbania improved fallows for eastern Zambia: an extension guide. ICRAF, Nairobi: International Center for Research in Agroforestry, (1998).

Kwesiga, F., Franzel, S., Place, F., Phiri, D., Simwanza, C.P. "*Sesbania sesban* improved fallows in Eastern Zambia: their inception, development and farmer enthusiasm." *Agroforestry Systems* 47, (1999): 49-66.

Litow, P.A. "Food security and household livelihood strategies in the Maya Biosphere Reserve: The importance of milpa in the community of Uaxactún, Petén, Guatemala." Master's thesis, University of Florida, 2000.

Minae, S., and Msuku I.R (eds). Agroforestry Potential for the land use systems in the unimodal plateau of Southern Africa, Malawi. Agroforestry Research Networks for Africa (AFRENA) Report No.5, (1988).

MS Access. Microsoft Access 7.0 for Windows, 2000.

MS Excel. Microsoft Excel 9.0 for Windows, 2000.

Mudhara M. "Assessing the livelihood system diversity of smallholder farm households: potential of improved fallows in Zimbabwe. Ph.D. Diss., University of Florida, 2002.

Nair, P. K.R. *An introduction to Agroforestry*. Kluwer Academic Publishers, 1993.

NSSA. National Sample Survey of Agriculture 1992/93 Volume II. Smallholder Garden Survey Report. Malawi Government, National Statistical Office, Zomba, Malawi.1993

NSO. Malawi Population and Housing Census, 1998 Preliminary Report. Malawi Government National Statistical Office, Zomba, Malawi, 37pp, 1998.

Nye, P.H., and Greenland, D.J. The soil under shifting cultivation. Technical. Communication No.51. Commonwealth Bureau of Soils, Harpenden, UK,1960.

Quisumbing, A.R., Brown, L.R., Fieldstein, H.S., Haddad, L., Pena, C. *Women: The Key to Food Security*. IFPRI. Food Policy stat. No. 21. 1995.

Quisumbing, A.R. "Gender differences in agricultural productivity: methodological issues and empirical evidence." *Economic Development and Cultural Change* 24, (1996): 1579-1596.

Sanchez, P.A., Improved fallows come of age in the tropics. *Agroforestry Systems*, 47 (1999): 3-12.

Scherr, S.J. "Not out of the woods yet: Challenges for economic research on agroforestry." *American Journal of Agricultural Economics* 74, (1992): 802-809.

Schrage, L. E. *Optimization Modeling with LINDO.* 5th Edition, Brooks/Cole Publishing Company, Pacific Grove, CA, USA. 1997.

Shapiro, B.I., Sanders, J.H. "Fertilizer use in Semiarid West Africa: profitability and supporting policy." *Agricultural Systems* 56,(1998): 467-482.

Sullivan, A.J. "Decoding diversity: mitigating household stress." Master's thesis, University of Florida, 2002

Sullivan, A. J. This volume (2002).

Thangata, P.H. "The potential for agroforestry adoption and carbon sequestration in stallholder agroecosystems of Malawi: An ethnographic linear programming approach." Ph.D. Diss., University of Florida, 2002.

Young, A. *Agroforestry for Soil Conservation*. 2nd edition. Oxford, UK: CAB International, 1997.

Young, A., and Brown, P. *The Physical Environment of Northern Malawi: with special Reference to Soils and Agriculture.* Bulletin on Northern Malawi. Government printer. Zomba, Malawi, 1962.

Zeller, M., Diagne, A., and Mataya, C. "Market access by smallholder farmers in Malawi: implication for technology adoption, agricultural productivity and crop income." *Agriculture Economics*.19, (1998): 219-229.

Reference Style: The following is the suggested format for referencing this article: Thangata, Paul H., Peter .E. Hildebrand, and Christina H. Gladwin. "Modeling Agroforestry Adoption and Household Decision Making in Malawi." African Studies Quarterly 6, no. 1&2: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a11.htm

Editor's Note: Readers please note that due to an oversight a draft version of the present article was online from July 30, 2002 until August 23, 2002. The current article replaces that version. Readers who may have cited material from the article should take special note of this change. We apologize for the inconvenience.

Gender-Sensitive LP Models in Soil Fertility Research for Smallholder Farmers: Reaching de jure Female Headed Households in Zimbabwe

MAXWELL. MUDHARA, PETER. E. HILDEBRAND, AND CHRISTINA. H. GLADWIN

Introduction

Zimbabwe faces a challenge in meeting food requirements of its 12 million people. The population is growing at three percent per annum compared to 1-1.5 percent per annum growth in agricultural production. Therefore, per capita food production is declining. To meet its food requirements, the country needs a four percent per annum growth rate in agricultural production.[1] Residents of smallholder farms comprise seventy percent of Zimbabwe's population. In 1999, they only contributed 14 percent of the value of sales of principal crops, i.e., maize, groundnuts, sorghum, soybeans, coffee, wheat, cotton, tobacco and sunflower. The contribution of smallholder farmers to marketed crops is skewed, with only a small proportion participating. The majority of the smallholder farmers struggle to meet their subsistence food requirements. High levels of poverty on these farms exacerbate the food problem, as they are unable to purchase food from the retail markets. Therefore, their food security is fragile.

Crop yields in the smallholder crop-livestock based production systems are low. Farmers plant hybrid maize seed that has potential yields of up to 12,000 kg ha^{-1}. Yet, average maize yields of 1,300 kg ha^{-1}, ranging from 350 to 2,200 kg ha^{-1}, are realized.[2] The disparity in potential and actual yields suggests that yields realized by farmers can be raised from current levels. Higher yields would enable farmers to meet their food and cash requirements, thus improving their food security status. More resources are required for achieving higher yields, yet smallholder farmers face multiple resource constraints. Financial capital, farming implements and draft power are limiting. The soils on which smallholder farms are located are inherently of low fertility. Due to over population, smallholder farmers have encroached on to the marginal lands, which have even lower yield potential. Infertile soils and lack resources to improve soil fertility threaten the goal of increasing smallholder farmers' food production.

Farmers have hitherto not adopted the higher levels of fertilizer application recommended to them, as they are incompatible with the limited resources of the farmers, especially women farmers. Traditional economic analyses for evaluating new technologies commonly only consider the production gains of a particular enterprise, with and without the technology, and ignore the impacts on the rest of the farm. Rohrbach noted that this approach errs in inferring that if a technology is profitable, it will attract capital and labor investments for its adoption.[3] Instead, the technology needs to be more profitable than alternative investment opportunities

http://www.africa.ufl.edu/asq/v6/v6i1-2a12.pdf

ISSN: 2152-2448

for the farm as a whole. The assertion in this paper is that there is a need for gender-sensitive methodologies to help research, extension and policy makers determine technologies likely to be adopted by farmers before a technology is propagated. Using such methodologies, the potential impact of various policies on farmers' livelihood systems can be determined.

This paper develops a Linear Programming (LP) model to determine the influence of gender of head of household on how households are likely to respond to technological options and economic policies. The impacts such technologies have on livelihoods of farm households are considered. Female-headed households (FHHs) have fewer resources, particularly male labor required for specific activities on the farm, compared to male-headed households (MHHs). With fewer resources, FHHs are more likely to adopt technologies that require less of their limiting resources.

HOUSEHOLD MODELS

Household modeling, based on the new household economics theory introduced by Becker that considers households as unified units of production and consumption, is appropriate for the unique characteristics of smallholder farmers. Smallholder farmers produce (using family labor) and consume their own product, which distinguishes them from most firms economists have studied.

In the new household economics theory, households maximize utility subject to a resource and time constraint.[4] Cases studies have given further support to this theory.[5] Given that smallholder farmers are rational and maximize cash incomes subject to fulfilling subsistence requirements, they are expected to respond positively to economic stimuli so hypotheses about their responses to economic policies can then be made. Therefore, economic variables in LP models, e.g., prices of inputs, can be adjusted to determine how farmers are likely to respond.

Smallholder farmers' livelihood systems can be represented by LP models. The household LP model is a set of equations, including an objective function that the household seeks to optimize, e.g., income, as well as a set of constraints that the household must satisfy, e.g., subsistence requirements. The model handles multiple cropping activities undertaken on the farm by representing them as different columns of the LP matrix.[6] Different constraints on the small farm household are then represented by the different rows of the LP matrix. Production and consumption decisions can then be accommodated by the model.

In the LP model, the profitability to the households of using new and old technologies can be compared. The constraints can be gender specific, such that the effects of different genders of the household head on the objective function can also be determined. In addition, the model evaluates compatibility of new technologies with levels of resources available to the households, which may vary over time. Decisions about allocation of cash to different goods (including farm goods for own consumption and leisure) and the allocation of fixed and variable inputs to different production activities in the short run can be incorporated. LP models are flexible: assumptions, technical coefficients, and activities in the farming system can be changed. Single or multiple objectives can be incorporated in the model, e.g., subsistence food requirements and income. This makes such a model particularly appropriate because farmers often consider several options at the same time when making decisions that affect their welfare.

The solution to the LP model gives the optimum livelihood activities undertaken by a specific household, such as crops produced under different technologies or off-farm income-earning activities undertaken by different family members. A solution corresponds to a set of household, market, and institutional conditions. The solution leads to a particular set of livelihood strategies for the household. Changing the set of conditions also changes the solution to the model so that a different type of livelihood becomes feasible. Models have "infeasible solutions" when the constraints are not satisfied, e.g., when subsistence food requirements are not met by the combination of household production and income-earning activities. In this case, the results imply that the household's livelihood system is not *sustainable*.[7] In other words, the household requires external support to survive over the time period specified.

Crops or crop techniques that might be used by farmers but are not currently in use, can be introduced into models to assess their potential for adoption, *ceteris paribus*. [8] The case of a cowpeas green manure crop with residual effects lasting two years after application, is used to illustrate how the introduction of a nitrogen-fixing crop for ameliorating soil fertility would affect the livelihoods of households with heads of different gender. Cowpeas were selected for this study as it performed well during evaluations of green manure alternatives conducted on farm. The crop is already grown by farmers but in tiny quantities. Its seed and leaves are consumed. Sample farmers indicated that among the crops they already grow, they would be willing to plow cowpea biomass into the ground to enhance soil fertility. A cowpea green manure crop is ideal for resource poor smallholder farmers as it does not require huge direct cash costs as they only require seed, labor and draft power. Farmers also indicated that they would plant maize in a plot in which cowpea biomass had been incorporated. In another survey in an area with similar circumstances, farmers expressed unwillingness to plant traditional green manure crops such as sun hemp and velvet beans. The traditional legume crops were resented since they are not edible and besides, farmers would need to purchase the seed for such crops. [9]

DESCRIPTION OF THE STUDY SITE AND ITS FARMING SYSTEM

Primary data were collected in 2001 from Mangwende Communal Area (CA). The CA is located in the north east of Zimbabwe, 90 kilometers from the capital city of Harare. Administratively, Mangwende CA is divided into five areas. An area is split into 28 wards. On average, each ward has 1000 households.

Based on head of household, three types of households exist in the area. There are MHHs, where the male head is resident on the farm, FHHs where the male head is not residing on the farm (*de facto* female-headed) and FHHs, where there is no husband (*de jure* female headed).

Maize is the staple food and major cash crop in Mangwende CA. Any surplus to subsistence requirements is sold. About 80 percent of revenue from crop sales is from maize. It occupies approximately two thirds of the cultivated area and absorbs close to 60 percent of the total household labor used for farming. [10] The planting of maize is staggered to reduce the burden on labor and to avoid the need to have all purchased inputs in place at the same time.

Staggering of plantings also minimizes the risk of failure of the maize crop due to mid-season drought. It also prolongs the period over which farmers can harvest green maize for consumption. Chemical fertilizer and cattle manure are applied on maize crops. Other crops grown in the area are finger millet, pumpkins, groundnuts, beans, sweet potatoes, cotton, cowpeas, Bambara nuts and sunflower.

Cattle are the dominant livestock. They provide draft power, manure and milk. Ownership of cattle influences the cropping pattern. Farmers with cattle usually have larger arable holdings, achieve better land preparation, weed on time, apply manure and achieve higher levels of agricultural production compared to non-cattle owners. [11]

SAMPLE SIZE AND SAMPLE SELECTION

Three wards were randomly selected out of the 28 in the CA. Thirty-five households were selected randomly from each ward, to give a sample size of 105 households. A household was defined as a group of people sharing food from the same kitchen permanently.

A structured questionnaire was administered to the sample. Informal discussions were also held with the households. In addition, three focus group meetings, where discussion guidelines were used, were convened in different locations within the study area. Groups provided data on the labor requirements of various farming operations, e.g., land preparation, planting, weeding, harvesting etc., which were based on general practices in the area. Gender-differentiated labor requirements were specified for operations undertaken using ox-drawn implements versus hand-held implements. The next section presents the constituent elements of the model and assumptions of the model regarding their use.

DATA USED IN THE LP MODEL

Crop yields

A production function, quadratic with respect to top dressing fertilizer applications rates, was developed for maize. Variables included in the production function and the signs expected on their coefficients are presented in Table 1. Coefficients of the production function are presented in Table 2. In the LP model, maize yields were obtained from the production function.

Table 1: Variables included in the Maize production function

VARIABLE NAME	VARIABLE DESCRIPTION	EXPECTED SIGN OF COEFFICIENT
Maize yield in 2001	1000 kg/ha	Dependent Variable
Compound D (7 percent N)	kg/ha	+
Ammonium Nitrate	kg/ha	+

(Ammonium Nitrate)^2	(kg/ha)^2	-
Organic Addition	Yes/No variable: 1 = Manure or other organic matter; 0 = No organic matter	+
Frequency of meeting with extension	Yes/No variable: 1= More than three times per year = 1; 0 = Less than three times per year	+
Draft Power Ownership	**1= Owners; 0 = Non-owners**	**+**
Total farm size	Area in Hectares	**+**
Time of Planting	0= Planted after 15 December; 1= Planted before 15 December	**-**

Table 2. Regression Coefficients of the maize production function

	VARIABLE SIGNIFICANCE LEVEL	**COEFFICIENT**	**STANDARD ERROR FOR COEFFICIENT**
Compound D* (kg/ha)	0.000170	0.000960	0.8593
Ammonium Nitrate (kg/ha)	0.010142	0.002682	0.0002
Ammonium Nitrate (kg/ha)^2	-0.000012	0.000001	0.0757
Organic Addition	0.117557	0.227740	0.6064
Frequency of meeting with extension	0.568046	0.207931	0.0069
Draft Power Ownership	0.439930	0.202655	0.0313
Total farm size	0.177394	0.994460	0.0762
Time of Planting	-0.515524	0.253945	0.0439
Constant	0.254294	0.319724	0.4275
Significance F = 0.0000	Adjusted R square = .026		

The coefficients in the regression model have the expected signs. Coefficients for Compound D and whether manure was applied were not significant. In the case of Compound D, the lack of significance of the coefficient could arise from the time when it is applied. Farmers apply it after the crop has emerged so that they only use the meager resources on plants that are already growing. This might limit the response of the crop to the basal fertilizer. Regarding manure, previous studies have alluded to the problems associated with manure in the smallholder farming sectors. Manure is of poor and variable quality, limiting its effectiveness in improving plant growth. [12]

The model was structured to accommodate the multiple plantings that farmers established. Survey results showed that 63 percent of the sample farmers had two plantings, 19 percent had one, 16 percent had three and one percent had four plantings of maize in separate plots. Plantings were spaced at two-week intervals. Maize was planted over the period from the end of October to early January. Seven percent of the maize plots were planted during late October. Thirty percent of these occurred over the first two weeks of November, 26 percent were planted during late November, 22 percent in early December, 13 percent in late December and two percent in early January.

LABOR REQUIREMENTS FOR MODEL ACTIVITIES

Smallholder farmers typically use family labor, with each member of the household old enough to participate in farming operations contributing. Because members often have different skills, labor might have to be allocated to different tasks, to maximize the contribution of each member. Males do most operations that use ox-drawn implements. However, when male labor is not available, females participate in the operations or male labor is hired.

Labor input coefficients into different operations were obtained from focus groups. Labor requirements for land preparation depend on whether or not a household uses draft power. Households without draft power need to hire it at a cost. Further, households without draft power use hand hoes for weeding while those with draft power use ox-drawn cultivators in combination with hand hoes. This has implications for labor use, particularly female labor. Hand hoe weeding requires more labor than do combinations of hand hoes and ox-drawn cultivators. Since female labor is usually used for hand weeding in households where labor use is differentiated, more female labor is required when there is no draft power.

The differentiation of labor by gender when undertaking operations is included in the model, although all family members take part in maize production activities. In 52 percent of the sample, male and female labor is differentiated during farming operations. When labor is differentiated, men use the ox-drawn implements. Females undertake planting and weeding using hand hoes in groundnuts, Bambara groundnuts and finger millet. When households do not differentiate their labor, males undertake operations that require ox-drawn implements and still take part in weeding with hand hoes.

Manure is dug out of the cattle pen, transported and spread by males. Therefore, households that do not have male labor would not be able to use cattle manure, unless they can hire it. This is common with *de jure* FHHs. Table 3 shows the differentiation of labor by gender.

Table 3. Differentiation of operations by gender

Crop and Operation	Male	Female
Plowing	X	X
Maize Planting: Hand hoes In plow furrow Weeding: Hands Ox-drawn cultivator Ox-drawn plow	X X X	X X
Groundnuts/Bambara Groundnuts Hand hoes planting Hand hoe weeding	X X	X X
Finger millet Planting by dribbling behind plow Hand hoe weeding		X X
Cotton Planting in plow furrow Weeding: Using cultivator Hand hoes Harvesting/Picking	X X X	X X X
Sweet Potatoes Hand hoe made planting beds Hand hoe weeding	X X	X X
Sunflower	X	X X

Planting by dribbling in plow furrow Weeding: Using cultivator Hand hoes		
Cattle manure Digging Transporting Spreading	X X X	

RESOURCE CONSTRAINTS

Resource constraints in the model included cash at the beginning of each year, labor (differentiated by gender) available at different times of the year, and land area available to the households.

The composition of the household determines available family labor. Additional labor can be hired in when cash is available. Hired-in labor and family labor are regarded as perfect substitutes. Labor can also be hired out for a daily wage. Labor days are divided into two-week periods to take account of the congestion of the activities between late October and the end of March. Households report facing labor constraints during this period.

Cash at the beginning of the year

This variable is the cash used for farming from the beginning to the end of the season obtained from sources such as sales of the previous crop, remittances, and non-farming activities. Use of credit has been declining over the years. Credit was used by 26 percent versus 6 percent of the sample farmers in 1990 and 2000, respectively. In 2000, credit was only available for groundnut inputs.

Household subsistence consumption requirements

Typically, semi-commercial smallholder farm households grow and store some food for consumption. The quantity of the staple food crops that each household stores every season was obtained during from the survey. These requirements are consumption constraints in the model.

A three-year LP model was constructed and run for all sample households. In each run, dimensions of specific households obtained from the questionnaire survey and average coefficients from group interviews were used. The objective function in the model was to maximize disposable cash income at the end of the third year.

Cowpeas technology

The LP model assumes a cowpea crop is planted in the first year, maize in the following two years of the three-year model. The model assumes the cowpea biomass is incorporated soon *after* the pods are harvested but *before* the leaves are dry, as opposed to the more conventional assumption that the biomass of the "green manure" crop is incorporated green, i.e., before it sets seed. In agreement with Uttaro's results here, the conventional approach is rejected here because smallholders plant grain legume crops in their farming systems for food rather than for soil fertility. Food security is their primary concern.

In on-farm trials of cowpea improved fallows in Mangwende CA, it was observed that maize yield improvements from residual effects of cowpea were observed in the first two seasons after the cowpea fallow. Thereafter the fallows species or duration had no effect on the maize yields. [13] Maize planted after a cowpea crop produced yields between 4000 and 6000 kg per hectare in the on-farm trials. [14] Maize yields realized in the first season following the improved fallow declined by 10 percent in the second season. The residual effect of high quality biomass after the second year was found to be very low. [15] In the LP model in this paper, it was therefore assumed that the residual soil fertility benefits of cowpeas last for two seasons after incorporating their biomass, with a 10 percent of yield reduction in the second season.

The analysis of the effect of introducing cowpeas proceeded as case studies of three households differentiated by the gender and marital status of the household head, to see the effect of gender on potential adoption of cowpea technology. One household was headed by a male resident on the farm (MHH), the second was headed by a male who resided away from the farm (*de facto* FHH), and the last household was female-headed (*de jure* FHH). The composition of the households is given in Table 4. In the sample, 50 percent were MHHs, 29 percent were *de jure* FHHs and 21 percent were *de facto* FHHs. This distribution of the households shows that females (*de jure* or *de facto*) constituted a significant part of the decision makers in smallholder farms.

Table 4. Household composition of case study households

Gender	Labor contribution	De jure FFH 29 percent	De facto FHH 21 percent	MHH 50 percent
Males	Full time working adults	0	0	2
	Part time working adults	0	1	0
	Working school children	0	1	0
	Non-working children	2	0	0
Females	Full time working adults	2	1	1
	Working school children	2	2	1

	Non-working children	0	1	0

To allow for comparison across households, selected households had Z$6,000 cash at the beginning of the year, the average that MHHs and *de jure* FHHs reported during the survey. The average for *de facto* FHH was Z$9,400. The higher beginning cash is expected because the male heads in these households were away and probably working. They would remit funds for farming activities. All households also had draft power. That the households possess draft power means that the group represents the better off farmers. The size of the arable land was 2.5 hectares, which was the average for the sample.

RESULTS AND DISCUSSION

Verification of the model

To see how well it simulated the livelihood systems of the sample households, results from the model were verified by comparing them to those from the survey. The two variables used for verification were the area under maize, the major crop in the system, and the arable area left fallow. The difference in the area obtained from the model solutions and from the survey was not statistically significant ($p \leq 0.1$). A correlation coefficient of 0.67 existed between the areas planted to maize obtained from the two data sources. A similar test on the arable area left fallow showed that the model closely reflected the survey data. The area reported to be under fallow in the survey data was not significantly different ($p \leq 0.05$) from that obtained from the model. The two fallow areas had a correlation coefficient of 0.72. This verification suggests that the model simulates the sample households well and is adequately robust to be used for establishing how households with different characteristics are likely to respond to interventions in their livelihood systems. Such interventions can be in the form of new technologies or new policies. The effect of such technologies on the households is then predicted from the results of the model. The model can then be used to assess the potential adoption of new green manure technologies, specifically cowpea technologies, on households headed by *male* heads versus *de jure* female heads versus *de facto* female heads.

Fertility Management

The assessment of the potential impact of the cowpea green manure technology was conducted by evaluating the performance of case study households, before and after the introduction of the technology. Before the introduction of the cowpea green manure into the model, households only relied on chemical fertilizers or combinations of chemical fertilizers and cattle manure for improving the fertility of their soils. The *de jure* FHHs did not use any manure because it required male labor, which they did not have. *De facto* FHHs with male heads of households only working part-time on the farm applied manure on 0.16 hectares. The MHHs applied cattle manure to 0.4 hectares of the arable land in the first season.

After the cowpea green manure technology was introduced into the model, the *de jure* FHH planted 0.4 hectares to cowpeas in the first season. The *de facto* FHH and MHH planted 0.31 and

0.74 hectares to cowpeas in the first season, respectively. The area planted to cowpeas by the latter two households was additional to that planted to maize with manure.

The net effect of adopting the cowpea technology can be seen in the cash incomes maximized by the different kinds of households in Table 5. The *de jure* FHH had the least income at the end of three years, with and without the cowpea green manure technology. Without the cowpea green manure technology, the income of the *de jure* FHH at the end of three years was Z$2,940 and Z$1,810 less than that for the *de facto* FHH and the MHH, respectively. With the cowpea green manure technology, which was adopted by the *de jure* FHH, the disparity in income levels decreased to Z$2,690 and Z$1,700.00 compared to that of *de facto* FHH and MHH, respectively.

Table 5. Incremental effects of cowpea green manure on end of year income

Type of Household	**Season**		
	1	**2**	3
De jure FHH	**550**	**900**	**360**
De facto FHH	40	290	110
MHH	-80	610	240

Table 5 shows the incremental change in the end of year income that farmers realized over the three-year period. The *de jure* FHH received the highest increase in disposable income from the use of cowpea green manure in all years. Therefore, even though the cowpea green manure technology can potentially be adopted by all types of households, the marginal effects of the technology depend on the technologies that households were using before introduction of the new technology and the resources available to the household. In this study, the *de jure* FHH, which had the least income level before adopting the cowpea technology, realized the largest positive impact on their income from the introduction of the cowpeas. These findings suggest that when identifying disadvantaged households, researchers should identify the factors contributing to the disadvantage so that appropriate interventions can be designed.

These results also counter the consensus opinion in the WID literature that de jure and de facto female-headed households are equally disadvantaged in resources and ability to utilize technologies. [16] The *de facto* FHH had the highest income before and after the introduction of the cowpea technology. This household used cattle manure because it had access to male labor, albeit limited. This indicates that only some of the female headed households are disadvantaged in their ability to adopt technologies. Indeed, farmers in the study site testified to the effect that some *de facto* female-headed households performed at par or better than male headed households.

Conclusion

In this paper, an LP model that is sensitive to smallholder farmer circumstances was described and used to show the differential impacts of cowpea technology on cropping patterns of *de jure* female-headed households, *de facto* female-headed households, and male-headed households in Zimbabwe. The robustness of the model to handle the diverse characteristics of smallholder farmers was illustrated by the ability of the model to simulate sample farmers.

Results suggest that women farmers in general and female-headed households in particular are not a homogenous group; and for the purposes of design of appropriate soil-fertility technologies, they need to be disaggregated to identify the constraints that hinder (or promote in this case) the adoption of specific technologies. The case study presented here of the potential adoption of cowpea technologies shows that *de jure* female-headed households would have more to gain by adoption of cowpea technologies, although MHHs and *de facto* FHHs would realize higher disposable cash incomes compared to the *de jure* FHH households. The availability of male labor is key to this result. Part time male labor available to the *de facto* FHH household enables it – as well as MHHs -- to apply cattle manure and thus decreases their demand for a substitute soil-fertility amendment in the form of cowpeas. Without male labor and thus cattle manure, *de jure* FHHs should realize the highest percentage increase in their incomes from adoption of cowpeas. Therefore, the technology should be more attractive to these *de jure* female-headed households than those with higher incomes, and we therefore predict a higher adoption rate of cowpeas by *de jure* female-headed households in Mangwende, Zimbabwe.

This paper showed how household LP models can be used for understanding why households undertake different activities or adopt different technologies. For the purposes of this volume, it also shows what soil-fertility interventions are capable of reaching which subgroups of women farmers, given the assumption they are not all alike. Development efforts can be made sensitive to characteristics of different households such as gender and marital status. Realization of the specific traits that make technology adoption possible and the effects that the technologies would have on the potential adopters will assist policy planners in redirecting technology development to households most in need of technologies. Technologies can also be designed to achieve the desired effect on households, such as meeting subsistence food requirements, reducing the female labor requirements during specific activities, and increasing total household income. Technologies developed with a clear objective, a specific problem to be solved, and a specific target clientele in mind are likely to be adopted.

Notes

* Compound D is 8 percent Nitrogen, 14 percent Phosphate and 7 percent Potassium.

Ammonium Nitrate is 34.5 percent Nitrogen

1. Pingali and Binswanger, 1998

2. Farm Management Research Section, 1990
3. Rorhbach 1997
4. Nakajima, 1965 and Becker, 1965
5. Singh et al., 1986, Netting,1993; Ellis,1992 and Tibaijuka, 1994
6. Singh and Janakiram, 1986
7. Chambers and Conway, 1992
8. Timmer *et al*, 1983
9. Gatsi, at al, 2000
10. Masters, 1994
11. Cousins, Weiner and Amin, 1990
12. Mugwira and Murwira 1998
13. Mafongoya and Dzowela 1999
14. Chibudu 1997
15. Mafongoya et al 1997
16. Due 1991, Due and and Gladwin 1992

References

Becker, G.S. "A theory of allocation of time." *Economic Journal* 75. 1965 493-517.

C.S.O. Statistical Yearbook, Central Statistical Office 1997, Harare, 1998, 228 pp.

Chambers, R., and G. Conway. Sustainable rural livelihoods: practical concepts for the 21st century. Discussion Paper 296, Institute for Development Studies, University of Sussex. 1992.

Chibudu, C. Green manuring crops in a maize-based communal area, Mangwende: Experiences using participatory approaches. In Waddington, S.R.m Murwira, H.K., Kumwenda, J.D.T., Hikwa, D. and Tagwira, F. (eds). Soil fertility research for maize-based farming systems in Malawi and Zimbabwe. Proceedings of a Soil Fert Net Results and Planning Workshop held from 7-11 July 1997 at Africa University, Mutare, Zimbabwe. Soil Fert Net and CIMMYT-Zimbabwe, Harare, Zimbabwe 1998, 312 pp.

Cousins, B., Weiner, B. and Amin, N. The dynamics of social differentiation in communal lands of Zimbabwe. Review of African Political Economy 53: 5-24. 1992

Due, J.M. “Policies to Overcome the Negative Effects of Structural Adjustment Programs on African Female-Headed Households,” in: Gladwin, C.H., ed. Structural Adjustment and African Women Farmers, p. 103-127. Gainesville, FL: University of Florida Press, 1991.

Due, J.M., and C.H. Gladwin. “Impacts of Structural Adjustment Programs on African Women Farmers and Female-Headed Households.” American Journal of Agricultural Economics 73 (1991): 1431-1439.

Eicher, C.K. Facing up to Africa’s food crisis. *Foreign Affairs* 61: 151-174, 1982.

Eicher, C.K. Zimbabwe's maize-based green revolution: Preconditions for replication. *World Dev*. 23:805-8181, 1995.

Ellis, F., *Agricultural policies in developing countries*. Cambridge University Press, 1992.

Farm Management Research Section, *The second Annual Report of Farm Management Data for the Communal Area Farm Units, 1989/90 Farming Season.* Harare: Economic and Markets Branch. 1990.

Gatsi, T., Bellow, M.R. and Gambara, P. The adoption of soil fertility technologies in Chiota, Zimbabwe: Potential and constraints. CIMMYT Maize and Economics Programmes, Network Research Results Working Paper No. 6. 2000.

Gladwin, C.H. Gendered impacts if fertilizer subsidy removal programs in Malawi and Cameron. *Agric. Econ*. 7: 141-153. 1992.

Mafongoya, P.L., and Dzowela, B.H. Biomass production of tree fallows and their residual effect on maize in Zimbabwe. *Agroforestry Systems* 47: 139-151. 1999.

Mafongoya, P.L., Nair, N.P.K. and Dzowela, B.H. Multipurpose tree prunings as a source of nitrogen to maize under semiarid conditions in Zimbabwe. 3. Interactions of pruning quality and time and method of application on nitrogen recovery by maize in two soil types. *Agroforestry Systems* 35: 57-70. 1997.

Masters, W.A. *Government and Agriculture in Zimbabwe*. Westport: Praeger Publishers. 1994.

Mugwira L.M. and Murwira, H.K. A review of research on cattle manure as a soil fertility amandment in Zimbabwe: Some perspectives. In Waddington, S.R., Murwira, H.K., Kumwenda, J.D.T., Hikwa, D. and Tagwira, F. (eds). Soil fertility research for maize-based farming systems in Malawi and Zimbabwe. Proceedings of a Soil Fert Net Results and Planning Workshop held from 7-11 July 1997 at Africa University, Mutare, Zimbabwe. Soil Fert Net and CIMMYT-Zimbabwe, Harare, Zimbabwe 1998, 312 pp.

Nakajima, C. "Subsistence and Commercial Family Farms: Some Theoretical Models of Subjective Equilibrium." In C.R. Wharton (ed.) *Subsistence Agriculture and Economic Development*, Aldine Publishing, Chicago. 1969.

Netting, R. M., *Smallholders, Householders*. Stanford University Press, California. 1993.

Pingali, P. and Binswanger, H.P., "Population Density and Farming Systems: The Changing Locus of Innovations and Technical Change." In Lee, R.D., Arthur WB Kelly AF Rogers, G. and Srinvasan T.N. *Population, Food and Rural Development*. Oxford: Oxford University Press. 1998.

Rorhbach, D.D. Developing more practical fertility management recommendations. In Waddington, S.R. , Murwira, H.K., Kumwenda, J.D.T., Hikwa, D. and Tagwira, F. (eds*). Soil fertility research for maize-based farming systems in Malawi and Zimbabwe*. Proceedings of a Soil Fert Net Results and Planning Workshop held from 7-11 July 1997 at Africa University, Mutare, Zimbabwe. Soil Fert Net and CIMMYT-Zimbabwe, Harare, Zimbabwe 1998, 312 pp.

Singh, I. and Janakiram, S. "Agricultural Household Modeling in a Multi crop Environment: Cases Studies in Korea and Nigeria." In Singh, I., Squire, L. and Strauss, J., (*eds*.) *Agricultural Household Models: Extensions Applications and Policy.* Washington: World Bank. 1986.

Singh, I., Squire, L. and Strauss, J., (*eds*.) *Agricultural Household Models: Extensions Applications and Policy.* Washington: World Bank. 1986.

Smale, M. Maize is life: Malawi's delayed Green Revolution. *World Dev*. 23:819-831. 1995.

Tibaijuka, A., "The Costs of Differential Gender Roles in African Agriculture: A Case Study of Smallholder Banana-coffee Farms in the Kagera Region, Tanzania." *Journal of Agricultural Economics* 45(1) (1994): 69-81.

Timmer C.P., Falcon W.P. and Pearson S.R. *Food Policy Analysis*. Baltimore: The John Hopkins University Press. (1983).

Reference Style: The following is the suggested format for referencing this article: Mudhara Maxwell. , Peter. E. Hildebrand, and Christina. H. Gladwin . "Gender-Sensitive LP Models in Soil Fertility Research for Smallholder Farmers: Reaching De Jure Female Headed Households in Zimbabwe.." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a12.htm

Is Fertilizer a Public or Private Good in Africa? An Opinion Piece

CHRISTINA H. GLADWIN, ALAN RANDALL, ANDREW SCHMITZ, AND G. EDWARD SCHUH

Traditionally, fertilizer has been treated by economists as a private, not public, good. [1] Soil scientist Pedro Sanchez and researchers associated with the International Center for Research on Agroforestry (ICRAF), however, claim that ICRAF's agroforestry innovations should be adopted by African farmers as an inexpensive way to replenish their depleted soils. "Replenishing soil fertility" is important because it is the number-one natural resource in Africa currently being depleted: the nutrient capital of African countries is being mined, just like mineral deposits of metals or fossil fuels. [2] Soil fertility depletion on smallholder farms is the fundamental biophysical root cause of declining per-capita food production in Africa. Society as well as farmers must invest in soil fertility as a form of natural capital.

Soil fertility depletion in Africa has both private, on-farm costs (e.g., decreased crop production, increased soil erosion) and public, national, even global costs. These include: decreased national food security, exacerbated rural poverty, increased migration to urban areas, increased urban unemployment and social unrest. Public costs also include: increased stream sedimentation, decreased water quality, loss of soil carbon to the atmosphere, loss of adjacent forests, and decreasing biodiversity (as land extensification occurs).

Replenishing Africa's soils is possible, however, on the high phosphorous fixing soils of Africa. For an estimated 530 million hectares, phosphorus-fixation is now considered as an asset and not a liability as previously thought. [3] Inorganic fertilizers are absolutely necessary to overcome phosphorus (P) depletion on these soils. Large applications of phosphorus fertilizer can become 'P capital' as sorbed or fixed P, almost like a savings account, because most P sorbed is slowly *desorbed* back into the soil solution over 5-10 years. The larger the application rate, the longer the residual effect. If phosphorus is applied as a one time application of phosphate rock, the decomposition of organic inputs that produce organic acids which acidify the phosphate rock (e.g., the organic acids in *Tithonia diversifolia*, a common shrub in W. Kenya) can assist in desorbing P.

To reverse nutrient depletion of nitrogen, however, Africa needs a combination of inorganic fertilizer, biological nitrogen fixation technologies, biomass transfers of organic matter into the field, animal manure/compost, and/or trees whose deep roots capture nutrients from subsoil depths beyond the reach of crop roots (nutrients are transferred to the topsoil via decomposition of tree litter). Subsoil nitrate accumulation is not significant in all soil types, but it is in Nitisols and similar soils, which comprise 260 million hectares in Africa.

http://www.africa.ufl.edu/asq/v6/v6i1-2a13.pdf

ISSN: 2152-2448

Can nitrogen demands be met biologically? Yes, to produce *mid-range* yields of 4 tons/ha of food crops such as maize. But to produce higher yields of food crops of 6 tons/ha, combinations of organic and inorganic fertilizers are needed (recovery by crop of nitrogen from leaves of leguminous plants is lower, 10-30%, than recovery from nitrogen fertilizers, 20-40%). ICRAF's solution to soil fertility depletion involves replacing phosphorus lost over the last 20 years on these Nitisols by importing Minjingu phosphate rock from Tanzania. Nitrogen lost over the last 20 years will be replaced with nitrogen from agroforestry innovations (such as hedgerow intercropping with *Leucaena*, biomass transfer with *Tithonia*, manures improved with *Calliandra*, and improved fallow systems using N_2-fixing shrubs like *Sesbania sesban, Tephrosia vogelii, Gliricidia sepium,* and *Cajanus cajan*). How to pay for this one-time application of phosphate rock? Because there are national and global benefits to farmers' use of fertilizer in Africa, national and global institutions should also share the costs.

OPINIONS ABOUT SOIL FERTILITY REPLENISHMENT

What do agricultural economists have to say about this issue of the public benefits to private fertilizer use? To show both the diversity and consensus in their thinking, I first present my own opinions about this possible solution to the soil fertility depletion problem in Africa, given the results of our five-year "Gender and Soil Fertility in Africa" project. The reactions of three esteemed fellows of the American Association of Agricultural Economists (AAEA) given at the 1997 AAEA meetings in Toronto, Canada, follow.

Comments by Christina Gladwin

In 1987 I was part of a Robert Nathan team sent to Malawi to consult on the removal of fertilizer subsidies. I have not been the same since. As the two-month mission unfolded and I interviewed many farmers in three districts of Malawi about what they would do if fertilizer subsidies were removed, it became clear that fertilizer prices would increase, the quantity of fertilizer used would decrease (in line with micro-economic theory), and the quantity of maize produced per hectare -- by individual farmers and in the aggregate -- would also decrease. Farmers would use more land-extensification strategies rather than land-intensification strategies, switching from hybrid maize to local maize production because local maize did not require as much fertilizer to produce.The risk of hunger for individual households would also increase, because farmers in Malawi, accustomed to applying chemical fertilizers since the 1960s, did not operate enough land to be food self-sufficient. Furthermore, they could no longer apply animal manures as a substitute for chemical fertilizers, due to lack of grazing land and child labor to care for the animals. Hence with the removal of fertilizer subsidies, there was a need for a national safety net program in Malawi. At that time, however, safety net programs were nonexistent. I imagined dire consequences.

For a few years, no such dire events occurred, partly due to government's delaying the final removal of fertilizer subsidies and partly due to droughts in 1991 and 1993, which led to donor-supported free input grants programs. In 1994/95, however, the price of fertilizer increased 200 to 300 percent without corresponding increases in maize prices in 1995/96 and 1996/97. As Uttaro's paper in this edition shows, by 1997 farmers dropped their land-intensification strategies, with both men and women farmers shifting back from hybrid maize varieties to non-fertilizer-responsive local maize varieties. Aggregate maize production fell. This was followed by a massive devaluation of the Kwacha in August, 1998, and subsequent increase in maize prices (as shown by Anderson's paper in this edition). Many food-insecure households were threatened by the growing length of the hunger season, and the Malawi government responded in 1998/99 with a safety net program – called the starter pack program. But as demonstrated in Gough's paper here, because the starter pack was universally applied to all rural households, its benefits were too small to significantly increase cash incomes of the food insecure households who comprise the poorer 40% of the rural population.

How to reach the bottom two quintiles of the population in a poor African country remains a tough problem, and one that forces government to examine its funding trade-offs when designing a soil fertility replenishment strategy. If government allocates its scarce funds by importing Minjingu phosphate rock from Tanzania and distributing it free over a wide geographical area (relying on agroforestry innovations to replace nitrogen lost over the last 20 years), as Sanchez suggests, it might increase aggregate food production in the country. But would it address food insecurity in the country? No, the truly food-insecure can only be addressed via a safety net program targeted *directly* at them, not at all the households in a given area. Neither should government be persuaded by OECD donor countries with oversupplies of cereals to provide a maize safety net to farmers who know how to grow their own maize and can do it more cheaply with a fertilizer safety net. A maize safety net would only increase their dependency. A government concerned with improving food security but strapped for funds might spend them more wisely on a productivity-enhancing safety net program (PES-net) that would provide nitrogen-fixing seedlings or seeds to only the food-insecure households.

Findings from all the micro-level studies undertaken as part of the "Gender and Soil Fertility" project seem to agree. During the five years of the project, we analyzed several policy options with respect to whether they work for women farmers in Africa: fertilizer vouchers, small bags of fertilizer sold in local markets, credit and microcredit for fertilizer, grants of fertilizer, and the organic options (agroforestry innovations, legumes, animal manures, and combinations). In all the sites, we found location-specific and historical conditions made it difficult to generalize results across all the micro climes. Yet our conclusions may be summarized as the following:

·Fertilizer voucher distribution is almost non-existent in Africa. We did not find a naturally-occurring experiment in which to assess fertilizer vouchers targeted at women food producers.

·Small bags of fertilizer are bought in local shops by both men and women in MHHs, but are usually used on men's cash crops rather than on women's food crops. Small bags are rarely bought by FHHs. Fertilizer in local markets, unlike cement, is rarely sold by the kg.

·Credit targeted directly at women is problematic. For women in MHHs, it leaks to men in locations where cash income is the man's domain. Women use informal credit more than formal credit. Household composition also affects credit use, as FHHs are still considered bad credit risks.

·Grants of fertilizer targeted only at the poorest FHHs did not occur in Africa and where targeted universally at all rural households the impacts are not significant. Flexi vouchers for grants of fertilizer add more to household cash income while input grants add more to aggregate maize production.

·Women plant grain legumes for food and do not plow them under when green, so they do not serve as a soil fertility amendments in Africa.

·Lack of land, labor, awareness-knowledge, and technical-knowledge limit women's adoption of agroforestry innovations (e.g., hedgerow intercropping, biomass transfer, and improved fallows). But where land is available and extension efforts alleviate the lack of knowledge constraints, poor FHHs do test and adopt improved fallows, even more so than married women in MHHs.

·Combinations of small amounts of chemical and organic fertilizers may show promise, but again, we did not find a naturally-occurring experiment that was disseminating innovative new combinations of inorganic and organic fertilizers in a formal manner.

·Women's access to cash crops does not ensure their use of soil-fertility amendments, but does help relieve women's cash constraints, so that cash-allocation decisions may be made about fertilizer use. In locations where women receive credit for cash-crop inputs, they usually divert some of the fertilizer received from the cash crop to their food crops.

The conclusions reached by the individual papers in this issue, taken collectively, show that gender differences do affect the use of soil fertility amendments by African farmers.Results are hopeful for reaching women farmers in male headed households (i.e., married women) and men in MHHs. These two groups do have some good options for improving their soils in the form of small bags of inorganic fertilizers sold locally, microcredit programs for fertilizer use, safety-net programs, additional cash cropping, and organic options (including legumes and agroforestry innovations). But African women farmers are not all alike. For the poorer FHHs, the results do not paint a rosy picture. Their options are fewer because their resources of land, labor, and capital are less. In our opinion, their soil-fertility options boil down to cash cropping, nitrogen-fixation technologies (in the form of improved fallows or doubling-up legumes), and safety net programs. For these women, and thus 25 to 35 percent of African households, if improved fallow technologies do not diffuse or if markets for cash crops fail, soil fertility improvements will have to come in the form of safety net programs. The challenge for African governments and donor countries will be in designing and delivering safety net programs that can serve the dual goals of increasing agricultural productivity as well as helping food-insecure households survive the lengthening hungry seasons in Africa.

Comments by Alan Randall

Anybody who is comfortable with the notion of passive use values for environmental amenities might be able to find the public good in the problem under consideration here. When one thinks about public goods, several things come to mind: first, the notion of preferences, i.e., something has to be preferred by at least some people, and second, the notion of an isolation paradox, i.e., that there is something produced which is of some value to many people, but not enough value that anybody in particular can afford to pay the cost of it. But if a way were found to break the isolation and bring them all together, to share costs and as such generate benefits for each one that exceeded their own costs, that is, a private benefit that exceeds cost share individual by individual, then one clearly has an isolation paradox that is loosely called a public good.

What are some of the sort of things that might or might not be public goods? There is relatively little to guide us. There is the notion that extensification of land use for farming that would diminish biodiversity in Africa or elsewhere might represent a public bad, and there might be a public good in addressing this. The notion of soil as natural capital is not certain but should be kept as a possibility.Is poverty itself a public bad? Certainly lots of people prefer to live in a society where others are doing reasonably well -- although there are some reservations about this. What about social instability, such as occurs with urban migration? There might be a public good in keeping people productive and in place where they are.

Poverty and Social Instability as Public Bads

These concepts have to be formulated very carefully. The notion of defining other people as public goods is a little bit scary. Yet some of the impacts of loss of soil fertility in Africa -- demands on services, losses of biodiversity, etc. -- can be thought of as potential public bads.

It is clear that something ought to be done about replenishing Africa's soil fertility. The questions arises: why must it be addressed as some kind of extended micro economics? It perhaps might be sufficient to say in fact that it is a good thing, therefore go ahead and do it. Very few people see the world in quite the same way as welfare economists do, as utilitarian consequentialists. But there are lots of other people who do see the world that way: champions of various kinds and libertarians and contractarians and people who invent far fetched stories starting in the notion of natural rights. There are two ways to think about the sort of pluralism that emerges from that. One is that there is a stand-off between those who are consistently consequentialists about everything and those who are Kantian. Bernard Williams is writing eloquently at the moment for that notion of pluralism. But there is another view: that we are all ourselves pluralist in some kinds of ways, and we draw upon different traditions to answer different questions. There is a conversion process that turns us into consequentialists -- economists -- and makes us want to put everything in that framework. But the rest of the world does not necessarily do this. There is room for arguments in favor of allowing reasonably productive and prosperous farming in Africa at the expense of people beyond that sector. It does not necessarily need a contrived economic argument for justification, and the public good argument doesn't seem to hold water.

Finally, why does it seem important to make a welfare and efficiency argument for taking care of what seems to be a serious problem? In the United States, very poor economics was done in the 1970s, officially in the name of the forest service, to redefine benefits. The reason for that was that the commitment to maximization of benefits was simply premature. The support for it really wasn't there. There is a similarity here, where we have donor agencies that are committed to imposing world prices right down to the local level of people who are substantially distanced from world markets. So in some ways, we might pragmatically be forced to contrive an efficiency-type argument to do something that very likely should be done for quite different and thoroughly honorable reasons.

Comments by Andrew Schmitz

At a recent annual "Farming for Profit" conference in Saskatchewan, Grant Devine (on the board of directors of a large fertilizer producer), argued that the fertilizer industry was totally competitive. There had supposedly been no money in the fertilizer business for years so many people went out of business. But we have learned something about predatory pricing. Some firms exit the industry because other firms drive them out and then they drive the prices right back up. What happens as a result? Share prices go up.

Second, if you take a look at the total demand for fertilizer worldwide, the large growth in demand is obviously from India and China. Third, with respect to fertilizer applications and prices, I still am totally confused about the use of fertilizer, whether it be in Africa or Saskatchewan or wherever. Even in Saskatchewan we are still trying to find out whether there are any benefits to precision farming with very specific applications of fertilizer to different subplots of a field.We have no idea what the fertilizer response functions are in any area of the world, let alone Africa. Production functions vary all over the map.

Something that is even more disturbing is that yields have actually gone down in a large part of the world, even with heavy applications of fertilizer. The uncertainty of fertilizer use is due not only to the impacts of variations in amounts of fertilizer applied, but also to the impacts of soil degradation and soil fertility loss with continuous cropping. As a result, we're going to have to add more and more fertilizer just to keep yields constant. So what does this mean to Africa? It appears those soils have been cultivated for hundreds of years. How can one maintain the quality of those soils? We have a very serious problem of soil degradation.

On this whole topic, until we solve these problems and understand the production function, the applicability of economics is questionable. How much do we really know about how soils respond to fertilizer?

We recently wrote a book on Bulgaria on the topic of privatization in Eastern Europe. What was really frightening was how could Bulgarian farmers fertilize at the world market price of fertilizer, when government capped the price of wheat at $2.00 a bushel? Government policy was charging farmers essentially the full price of fertilizer at the international market price and then placing a cap on what they could export and at what price. It essentially squeezed farmers right out of the fertilizer market. With respect to fertilizer use in Africa, this means one also has to know the pricing policy of the main commodities to get a feel for whether fertilizer can be applied at <u>any</u> profitable price.

One can easily justify subsidizing fertilizer use based on the theory of "the second best." [4] If one is in a world of "second best," which in Africa is the case, one can easily justify an international cost sharing (i.e., subsidy applied to fertilizers). However, the issue of "second best" arguments is perhaps less contentious than how to effectively implement a subsidy so that it goes to the end user -- the farmer. What form should a subsidy take so that it doesn't end up being wasted by governments and/or the private sector? Often subsidies do not benefit those for whom they are intended because of the distribution system. If a subsidy program is designed poorly so that it ends up in the hands of middlemen, then it is of no use in helping local farmers out. Also, there are issues such as fertilizer price instability and relative prices of inputs versus outputs. Fertilizer prices are highly unstable. A major importer can gain from optimal fertilizer storage. One should examine subsidizing storage rather than placing direct subsidies on the input itself. Finally, what is the price of maize, for example, in Africa given that a large percentage of domestic food grown is consumed directly by the household? If this food is undervalued, then the case is weakened for increased use of fertilizer.

Comments by G. Edward Schuh

The Sasakawa Global 2000 project (SG 2000) in Africa combines the agronomic genius of Nobel Peace Prize laureate Norman Borlaug and the political skills of Jimmy Carter with the commitment to African development of the late Ryoshi Sasakawa and his son. In the 1980s, these three started a technology transfer project that is now operating in twelve African countries. In order to meet their policy advice needs they created a group called Agriculture Council of Experts (ACE), part of whose mandate is to put together policy papers. The first paper that was put together was called, "Fertilizer Policy in Africa: Recurring Issues and Recommendations". [5]

In order to increase fertilizer use, the issue of fertilizer profitability and a whole range of barriers or constraints to increased fertilizer use must be addressed. My comments detail these, and follow with a set of recommendations, which are presented here with little elaboration. The puzzlement about fertilizer use is that the low level of use is due to a large number of factors; and implementation of any fertilizer policy requires tradeoffs between some of these factors.

Barriers to increased fertilizer use

First, the lack of profitability in using fertilizer is due to unprofitable and unstable ratios between the prices of fertilizers and product prices, as has already been mentioned. If one looks at any of the current price ratios (of nitrogen fertilizer to maize, for example), it is clear why farmers do not use fertilizer. If one then looks at the instability in the price range, one can see why they do not spend a lot of time trying to learn how to use it unless it is highly subsidized.

Second, past dependence on heavy government intervention in the economy has led to unstable supplies, inappropriate fertilizer mixes, and lack of timeliness in delivery for profitable use. On the lack of relevance of fertilizer mixes, a lot of the fertilizer supplies have been the byproduct of aid programs. That doesn't necessarily mean that the market really isn't useful, it is often that some companies are trying to get rid of unwanted fertilizer blends and sell them to aid agencies at lower prices. The United States is not the only country guilty of doing this.

Third, there is uncertainty about the responses to fertilizer due to unstable weather patterns, lack of irrigation, and more importantly, unstable public policies.Fourth, there is lack of knowledge on the part of farmers about the use of fertilizers. African farmers implement all kinds of complex systems of multiple cropping and rotations of numerous crops. Decisions about how much fertilizer to use, and where and how to apply it, become a very complicated issue.

The fifth barrier to increased fertilizer use is lack of sufficient distribution systems for modern fertilizers that would facilitate delivery of input supplies to the farmers in a timely manner. The sixth barrier is lack of appropriate fertilizer mixes for local conditions. The seventh is lack of credit, from the small farmer to the retailer and the wholesaler in the entire fertilizer distribution system. The eighth barrier is lack of foreign exchange for importers to acquire adequate and appropriate supplies. The ninth barrier is lack of adequate research and extension systems to generate knowledge about fertilizer use and to diffuse that knowledge to the farm population.

The tenth and final barrier is an inadequate world transportation and communication infrastructure to reach distant areas and to ensure timely delivery. This issue is very neglected. The physical infrastructure that Americans take for granted is just not there. Consequently, when looking at the costs of getting fertilizer to the farms and getting the product back out, there are serious problems and escalating costs. Ultimately, the question boils down to whether government wants to use fertilizer subsidies to offset some of those kinds of costs.

Policy Recommendations

We suggest eleven policy recommendations for reducing and eliminating these ten barriers. [6] The first should not be surprising: trade and exchange rate policies are still wrong in most African countries, even though they underwent structural adjustment reforms and programs in the 1980s. Looking at their price, relative to product price at the port, fertilizers are still very unprofitable -- even at the port. Exchange rates are the most important price of the economy. If government doesn't get them right, it's not going to be able to do much about the profitability of fertilizer.

In addition, Africa still has rather large export taxes. Africa has specialized in export taxes that limit their own farmers' access to international markets. This drives domestic prices down to a very low level. Until governments begin to get some of these policies right, little other progress can be made. Trying to offset this with subsidies becomes a costly process, and leads to questions about obtainability. How long can we continue to provide those kinds of subsidies?

Second, present policy trends towards the privatization of the economy should be continued. It is imperative that a private distribution sector for fertilizer should be developed and that government withdraw from this activity. So much of the fertilizer industry in the public sector is filled with people who have no knowledge of agriculture or farming or fertilizer. In addition, the public sector has often been dull and slow and unresponsive.

Third, while little can be done about unstable weather, a great deal can be done about unstable policy. Out of unstable monetary and fiscal policies one gets unstable exchange rates. This leads to price uncertainty.

Fourth, expanded research efforts are needed to better understand semi-arid soils and to solve the very specific problems caused by lack of knowledge of local responses to the application of fertilizer. Similarly, expansion of extension efforts is needed in most semi-arid African countries, to help farmers learn new production practices and more economic use of their resources. Some international agricultural research centers (IARCs) are dominated by agronomists and physical scientists, but research on soils often ends up far down on the list of priorities. The truth of the matter is, very little is known about soils in most places in the world. We tend to think that increased agricultural output comes from the introduction of improved varieties. But underdevelopment can be caused by a soil problem and the solution can be a technological innovation produced by soil scientists who know the local soils. This is very applicable to large areas of Africa.

Fifth recommendation: An efficient distribution system for fertilizer will emerge only if the government withdraws from the sector and the use of fertilizer becomes profitable. Thus, government parastatals that occupy space in the fertilizer distribution system should be phased out quickly and macro-economic policies put in place to make agricultural production profitable. There is also a whole set of issues related to educating people in the private distribution sector, and setting up a strong extension program among fertilizer distributors so that they know something about fertilizer values. In the process they can learn about the risks and uncertainties involved in farming.

Sixth recommendation: It is difficult to generalize about fertilizer mixes. Proper mixtures vary enormously from country to country and from commodity to commodity. The only general recommendation would be that preference should be given to high concentration materials, largely because of the high transportation costs of fertilizer. Government can lower the transportation costs with high concentration materials. But fertilizer mixes still must reflect their local nutrition deficiencies and their commodities.

The seventh recommendation involves imperfectly performing credit markets, which are a major issue in Africa and other parts of the developing world. There is hardly any place in Africa with efficient financial intermediaries. Instead, state-controlled banks take money appropriated by the government and channel it into the financial system. Distribution is not always done equitably or appropriately. Major reforms in the banking system are needed, reforms that create financial intermediaries and institutions to mobilize savings and make it available to farmers. The best institutions are cooperatives and credit unions that mobilize savings from local farmers and then provide a mechanism for reinvesting it. To do something similar for the fertilizer distribution sector is more complicated. It requires examining the barriers and constraints that the fertilizer distributors face. They often cannot get access to credit either. So again, there is another whole set of institutional innovations badly needed.

The eighth recommendation focuses on how to get more realistic exchange rates. Government first needs to get trade policy right. It needs to get monetary and fiscal policy at least stabilized, so that they become neutral. With a flexible exchange rate, that is probably as good as it can be. Government is not going to eliminate all of the instability generated from the foreign exchange markets. But if it neutralizes fiscal and monetary policy, and gets trade policy at least uniform across sectors, it can do a lot to eliminate exchange rate distortions. At the same time, it will stabilize this most important macro price.

The ninth recommendation concerns lack of infrastructure in Africa. One of the tragedies of the developing countries is that when the World Bank became heavily involved in stabilizing macro prices and policy reform, it turned away from longer term investments in physical infrastructure. Consequently, the highway, railroad, and communication sectors in Africa are really non-existent. Africa cannot get very far until it has more physical infrastructure. It has a long way to go.

Tenth, more long-term investment in agricultural research and extension systems is also recommended. The stock of location-specific knowledge about agriculture in African countries is very, very limited.

Finally, one can hardly talk about fertilizer or fertilizer policy in Africa without talking about subsidies and the enormous pressure on African governments to provide subsidies. Norman Borlaug feels that to diffuse various improvements, Africa has to have more fertilizer use and the only way to promote fertilizer use is to subsidize it. Part of the problem, however, is that fertilizer subsidies have not been supplemented by government investments in infrastructure, institutions, and policies that *permanently r*educe farm level fertilizer prices (e.g., reducing transportation costs and increasing efficiency in the input and output markets). It is both more equitable and efficient to use scarce development resources to reduce or eliminate these constraints to the wider use of fertilizer. Fertilizer subsidies should be conditioned on investments that reduce the structural impediments to increased fertilizer use in the future.

At the same time, there is a certain degree of ambivalence on the whole subsidy issue. Eventually the question comes up, "what are the tradeoffs"? If government uses its scarce development resources to subsidize fertilizer in the short run, it has to be at the expense of longer term investments that eventually would lower fertilizer costs. What we as economists can contribute to this debate is to look carefully at the tradeoffs and estimate just how much long-term physical infrastructure versus how much of the domestic fertilizer industry can and should government subsidize. How much agricultural research can government provide if it is also subsidizing short-term fertilizer benefits that nobody would pay for privately?

Notes

1. Tomich et al. 1995: pp 255-258.
2. Sanchez et al. 1997. Smaling (1993) has estimated the depletion rates of soil nutrients as 22 kg/ha/yr for nitrogen (N), 2.5 kg/ha/yr for phosphorus (P), and 15 kg/ha/yr for potassium (K).
3. These soils are concentrated in central Africa.
4. Just and Schmitz 1982.
5. Ndayisenga and Schuh 1997.
6. Ndayisenga and Schuh 1997.

References

Just, Richard, and Andrew Schmitz. 1982. *Applied Welfare Economics and Public Policy.* Englewood Cliffs, N.J.: Prentice-Hall.

Ndayisenga, Fidele, and G. Edward Schuh. 1997. Fertilizer Policy in sub-Saharan Africa: Recurring Issues and Recommendations. ACE Agricultural Policy Series 1. Minneapolis: Humphrey Institute of Public Affairs.

Sanchez, P., A.M. Izac, R. Buresh, K. Shepherd, M. Soule, U. Mokwunye, C. Palm, P. Woomer, and C. Nderitu. 1997. Soil Fertility Replenishment in Africa as an Investment in Natural Resource Capital. In *Replenishing Soil Fertility in Africa,* R. Buresh and P. Sanchez, eds. Madison, WI: Soil Science Society of America Special Publication Number 51.

Smaling, Eric. 1993. An agroecological framework for integrating nutrient management, with special reference to Kenya. PhD Thesis, Agricultural University, Wageningen, Netherlands.

Tomich, T.P., Kilby, P., Johnston, B.F. Transforming Agrarian Economies. Ithaca, NY: Cornell University Press, 1995.

Reference Style: The following is the suggested format for referencing this article: Gladwin, Christina H., Alan Randall, Andrew Schmitz, and G. Edward Schuh. "Is Fertilizer a Public or Private Good in Africa? An Opinion Piece." African Studies Quarterly 6, no.1: [online] URL: http://web.africa.ufl.edu/asq/v6/v6i1a13.htm

BOOK REVIEWS

Shady Practices: Agroforestry and Gender Politics in The Gambia. Richard A. Schroeder. Berkeley: University of California Press, 1999. Pp. 172.

Scholars commonly abstract the realities of daily life in Sub-Saharan Africa in their efforts to conceptualize the institutions available to, the obstacles faced by, and the issues confronting communities, firms, households, and individuals throughout the region. Such abstractions (e.g., formal versus informal economies, modern versus traditional societies, urban versus rural biases) are appealing, in part because they simplify complex issues and contexts, create theoretically unambiguous boundaries between groups and philosophies, increase the clarity of arguments and allow scholars to present cogent cases in support of a particular approach to development policy. Although most are aware of the limitations of abstractions as a means for predicting human behavior, many agents and agencies in the development community eagerly integrate such theoretical simplifications *prima facie* into policy prescriptions and aid initiatives targeting African communities. As Richard Schroeder aptly demonstrates in his Gambian case study, such direct applications of development theory are often accompanied by "slippage" when conceptual ideas are processed into applied projects and programs by development institutions and agencies. In doing so, agents and agencies may mistakenly view such models and idealizations as being more representative of human nature and behavior than reality itself and this, in turn, may lead to project failures as implementation contexts and local power relations are inadequately accounted for in the design phase of a development initiative.

Shady Practices details over two decades of economic, ecological, social and spatial change in lowland farming systems in the community of Kerewan, situated on the North bank of the Gambian River. Schroeder focuses primarily on the garden systems developed by collectives of women starting in the late 1970s (up until 1995) on lands traditionally controlled by male elders. The book provides a detailed history of these gardens and describes how they were transformed from small-scale contributors to household welfare into primary sources of income for many families as traditional cash crops (e.g., groundnuts) became less tenable in the face of drought and structural adjustment policies. The story is particularly intriguing when Schroeder explains how women's success in off-farm crop sales bred resentment among many men (husbands) and led to conflicts within the community and households. In some cases, men attempted to regain control of lowland areas through the (re)assertion of traditional patrilineal land-use claims, especially as they related to earlier rules on tree planting and tree crop usufructory rights. Beyond detailing the dynamics of such gender politics, Schroeder shows how intra-household relations were influenced by foreign aid initiatives and also does a superb job of demonstrating how NGO project officers and state extension agents at first facilitated (through Women in Development [WID] based initiatives), and then obstructed (through

ISSN: 2152-2448

sustainable development programs), the development of women's garden plots in Kerewan. The longitudinal nature of this work allows the reader to observe the shifting sands of foreign aid programs in The Gambia over two decades and is therefore an excellent empirical case study that demonstrates some of the problems that arise when development objectives rapidly shift from one paradigm to the next. In this case, it is the shift in donor priorities from WID to sustainable development programs that enables men to regain some of the economic power lost to women as a result of their success in the gardens.

This book tells a fascinating tale rife with lessons about the dynamics of rural development processes, gender relations and the political economy and ecology of foreign aid. At its best, the book forces the reader to consider the complex ways in which intra-household and community power relations interact with foreign capital and ideas to influence the outcome of seemingly straightforward development programs. Moreover, the study questions some of the abstractions applied in the development of such programs and critiques contemporary theories on the role of women in development, the relationship between women and the environment, and sustainable development. In essence, Schroeder's book is one part political ecology, one part political economy and one part farming systems research that powerfully demonstrates the value of longitudinal studies that examine the dynamics of development at the local level within Sub-Saharan Africa.

The book is a brisk read that is divided into seven chapters and an extensive Preface. Chapter 1 introduces the study and presents a small sample of the literature (mainly that related to women in development and women's relationship with the environment) influencing Schroeder's approach to the research. Chapter 2 describes the farming systems of Kerewan and reviews the changes to these systems since the 1970s. Chapter 3 describes how husband-wife relations changed with women's success in the lowland production of horticultural products for off-farm sale and tells how foreign aid agencies actively aided women in the establishment and maintenance of the cooperative gardens. Chapter 4 details the labor inputs required by women to produce these crops and describes the difficulties faced by women trying to "calibrate" the labor outputs required for garden production in the dry season with those needed for rice production (a critical staple) during the rainy season. Chapter 5 examines the lowland garden system from the perspective of the landholders – the men – and describes how elders in the community began to regain control over lowland land claims through a renewed interest in tree planting and with the help of foreign aid agencies promoting sustainable development practices. Chapter 6 evaluates the net impact of men's attempts to reassert their power and presents some of the outcomes observed among the sample of garden sites researched by Schroeder. Chapter 7 raises interesting questions about the conceptual bases for many development initiatives and stresses the need to account for agents and power relations more readily in development theories and applied programs.

The book's main strengths derive from Schroeder's understanding of The Gambian context, gained through his experience living among and working with the Mandinka people; moreover, he efficiently details the social relations, economic practices and external influences (i.e., foreign aid and state sponsored programs) that have shaped (and reshaped) gender relations in a rural Gambian community. Ultimately, the book is a powerful case study that leads to four general conclusions: 1) idealized conceptualizations of women, as manifest in theories that view them as "nurturers" of the environment or as "maternal altruists" (willing to do anything to preserve the well-being of their families), may lead to development initiatives that ultimately undervalue the social and economic cost of women's labor; 2) the abstractions used by development agencies to model African households and farming systems may excessively blur the realities of daily life and ignore the power relations existing in a community, which can lead to unanticipated outcomes from aid initiatives; 3) rural women should not be viewed simply as helpless victims of patriarchal societies and male-dominated development processes, but rather as agents of change and as political actors engaged in a daily struggle to restructure a social and economic system undoubtedly biased against them; 4) donor and state agencies and actors often actively participate (knowingly or unknowingly) in gender relations at the household level, especially during the implementation or funding of development projects.

As for weaknesses, the primary concern is that the book reads a bit too much like it was carved out of a much larger text (i.e., a dissertation) and seems thin in terms of its conceptual grounding. This criticism in no way detracts from the value of the book as an empirical case study, only that it was difficult to situate the work within a broader theoretical tradition as the literature review was a bit narrow in focus and short in length. Another criticism relates to the fact that the Preface contains extensive and important information about the methods, history, and approach of the study that should have been weaved into the main body of the text. Otherwise, the book is extremely well written and the tables, maps and photographs are effective and informative throughout.

The book will be of interest to a variety of individuals in both scholarly and applied settings and will be particularly valuable as a tool to demonstrate the complexity of rural development processes in Sub-Saharan Africa. For students and teachers, the book can act as a useful case study in courses dealing with such diverse subject matter as gender, political ecology, cultural ecology, the political economy of development aid, sustainable development, farming systems, rural sociology and environmental ethics. For scholars, the Kerewan case offers an excellent base for comparative research on rural land-use systems in developing countries and on gender politics in Sub-Saharan Africa. In sum, *Shady Practices* is an important contribution to the literature on rural livelihoods, common property systems, gender relations, and development politics in Sub-Saharan Africa, and is a book that will serve as a valued resource on Gambian farming systems for many years to come.

James T. Murphy
Salem State College

Making Nice on Ethiopia: Believers, Heretics, and the Post-Imperial Transition

Ethiopia: A Post-Cold War African State. Theodore M. Vestal. Westport, CT: Praeger, 1999. Pp. 229.

Ethiopia: A New Start ? Kjetil Tronvoll. UK: Minority Rights Group International, 2000. Pp. 36.

Both volumes reviewed in this essay examine the politics, economy and society in Ethiopia over the 1990s. Yet it would be excusable, if slightly far-fetched, if some readers were to argue that Vestal and Tronvoll are concerned with two different societies, or with distinct historical periods in the same society. Consider the sub-titles of the works. Vestal's *A Post-Cold War African State* [hereafter *VE*] hints at a description of the "historical present" with or without particular analytic-theoretical commitments. On the other hand, Tronvoll's *A New Start* [hereafter *TE*] implies there had been *some* old, probably false steps. This in turn suggests both localized, cumulating experiences against which progress can be measured, as well as some institutional order-in-the-making.

The focal issues overlap yet differ, albeit slightly. *A Post-Cold War African State* is all-encompassing and ambitious, its arguments elaborated in eighteen chapters of varying lengths and analytic depth. Vestal's audience is no less varied – among them Africanists of all hues, as well as analysts of American foreign policy on the developing world. By contrast Tronvoll's subject, the condition of minorities in post-imperial Ethiopia, is more focused, as is the primary audience for *A New Start*: civil society organizations, minority groups rights activists, and advocacy communities in Ethiopia and elsewhere served by Minority Rights Group International, a non-governmental body based in the United Kingdom that commissioned the report. Notwithstanding the variations, both works have considerable appeal for students of transitions to democracy in 'non-Western' societies.

The basic pre-analytic question concerns the applicability of dominant conceptual-analytic categories. As Thomas Kuhn (1962 [1996], p. 113) counsels, all perceptions depend on both the object and the perceptors' training and experience. Put differently, observers impose order on reality by discernment effected variously, through prisms molded as much by societies under observation as by the attributes particular observers bring to bear on the problem(s) at hand. Of course, non-compliant situations are only to be expected from efforts to blend general abstracted statements with particular experiences. Still, Ethiopia is always likely to raise peculiar difficulties. Africa's oldest autochthonous state is also "a warehouse of images, a repository for obsessions and projections of various identities both from within the [African Horn] region and from without (Sorensen 1993, p. 3)." While each image and identity frame parades more or less well-articulated positions on distant and recent pasts alike, there is very little in form of a grundnorm on Ethiopia's present institutional frame or road map to a shared future.

Scholars and observers are no less divided, either. Vestal and Tronvoll also bring contrasting experiences to their tasks. Vestal's engagement with Ethiopia dates back four decades to the 1960s. As a young volunteer in the American Peace Corps program, Vestal saw in Ethiopia both "a heaven-blessed land of natural beauty and potential abundance (*VE*, p. xi)" and vast opportunities for the United States to extend its vision of modernization and progress around the world. Those early encounters would generate life-long friendships and social contacts, including with Ethiopians in residence in the United States. Now a political science professor, Vestal would also serve as advisor to the ruling Ethiopian Peoples' Revolutionary Democratic Front (EPRDF) in the early 1990s (*VE*, p. xv). Thereafter, he would publish critiques of the post-1991 transition in *Ethiopian Register* and the *Ethiopian Review*, two U.S.-based newsmagazines opposed to the Addis Ababa régime, and to which he has been editorial advisor. The move from advising EPRDF to advising opposition media might be deft politics, but there is no doubt Vestal is a true believer in Ethiopia and a well connected observer-cum-participant in its affairs. In turn Tronvoll belongs among new-generation Ethiopia observers, a Norwegian anthropologist who cut his scholarly teeth on the Horn region in Eritrea, on which he has done fieldwork on land tenure, served as observer during the 1993 referendum, and remained a noted commentator. Tronvoll has been far less 'involved' with Ethiopia; he is also the more dispassionate of the duo.

Vestal sets out to "bring *some* balance to description and analysis of events in Ethiopia *since* the EPRDF came to power (*VE*, p. xiii, italics added)." In this scheme, history either begins in 1991 or goes back no further than 1974. Nearly two decades of military rule under the *Derg* does not appear to have adversely affected his perceptions of historic Ethiopia. "The Ethiopia subjected to the power play of the EPRDF and EPLF [Eritrean People's Liberation Front] in May 1991," Vestal declares matter-of-factly, "was a shattered remnant of the land of promise that Western donor nations had analyzed and subsidized before the [1974] revolution (*VE*, p. 5)." The EPRDF government "purposefully intensifies ethnic distrust among the people," while the élite pact under which post-*Derg* Ethiopia was administered is dubbed the "charter of anomalies" for turning Ethiopia's unitary state structure inside out and for conceding Eritrean independence (*VE*, p. xiii; 7). Since the "carefully orchestrated pinchbeck elections of 1992," the EPRDF has persistently denied space to opposition groups and human rights activists yet managed to keep on the side of the US diplomatic and foreign aid establishment, the donor community, and Africanist constituencies (*VE*, p. 22; 52; 80; 85). In Vestal's eyes, it is not difficult to turn Ethiopia around; EPRDF operatives "beguile" and hoodwink *ad nauseaum* while major international actors, including the US, make nice, or pretend not to notice.

Reinforcing this anti-EPRDF outlook are two major considerations. One is Vestal's support for diasporic populations in the United States, those "educated cosmopolitan democrats [with] starkly different views of the theory of governance" *vis-à-vis* EPRDF élites (*VE*, p. 6). The other is a vision of democracy reflecting admiration by the exiled élites of *normative* political practices in their host societies, or of the open climate from which they have benefited (*VE*, p. 6-7). Attempts to project back home values acquired in the West have defined efforts to affect Ethiopia either by taking direct charge, or through relentless criticism of EPRDF and its functionaries.

It is not entirely surprising that diasporic Ethiopians are generally opposed to the sitting régime in Addis Ababa. Many have long been physically removed from their homeland and have not fully partaken in the multiple revolutions and endless internal wars in post-1974 Ethiopia. Moreover, exiled populations generally tend to hold on to versions of national history and sentiments they migrated with, or aspects thereof, which are amenable to memory and recall as conditions in exile permit. In Ethiopia's circumstances however, some traditional attitudes and practices are certain to have been swept away by Marxist doctrine or by pragmatic calculations on the part of domestic populations. This hiatus probably explains, at least in part, why some groups failed to transform their elegant rhetoric to *real* political capital in 1991 (*VE*, p. 57; 198-199). There is also much infighting within opposition ranks:

When[ever] the opposition gathered, it was like the lively junction of tectonic plates – the earth shifted and shuttered, but when things settled down, there was nothing but destruction to behold. Criticism of everyone was *de rigueur*, but it was not constructive. The more the division, the greater grew the contentions, and the greater the flow of words, the less the importance of what was said. The notion of compromise had little utility to wily strongmen leaders of personality cults, intent on maintaining their personal power, or to ethnic chauvinists who fostered distrust of all except the chosen few of their own kind… The clash of groups over questions which elicited radical disagreement engendered paralysis, squandered everyone's time, and exacerbated animosities (*VE*, 49).

While the mix of optimism and frustration in the opposition has considerable merit, the analysis underlying it is problematic. In a sense Vestal is judge, jury and executioner all rolled in one. He has been editorial advisor to *Ethiopian Register* and *Ethiopian Review*; his book draws copiously from fourteen of his own essays previously published in both; and his might well be *the* voice of Ethiopian groups in the US that are opposed to EPRDF! If the same groups are all chauvinistic and politically naïve, as Vestal also appears to suggest, it might well be that the transnational opposition is oversold, or the mantra on historic unity is slightly jaded.

On another level, *A Post-Cold War African State* rests on avoidably narrow analytic foundations. Apart from private correspondence from eyewitness accounts, mostly partisans or other participants implicated in the processes described, there are few primary sources *internal* to Ethiopia. By contrast 'wildcard' sources hint casual conceptual specification, one case being a legal decision in the United States cited in support of claims on press freedom in a poor African country without established traditions of division of powers or independent judiciary (*VE*, p. 58). More surprising perhaps, an analysis of secret EPRDF documents (*VE* chps. 7, 10) draws on English translations in *Ethiopian Register* without any backup whatsoever from news and views published *in* Ethiopia. Yet, since Vestal believes that Ethiopia's vernacular newspapers offer credible, in-depth commentary (see *VE*, p. 134), he *could* have had some of these translated into English. Such firsthand insights could have enriched the rather formal-structural overview of EPRDF thinking and certainly other issues.

Vestal and Tronvoll agree on the significance of EPRDF's near-total control over the state. However, Vestal is less willing to admit to its deep historical roots. According to Vestal, the desire to monopolize political power drives EPRDF to routinely set one ethnic group against another, disrupt a long Ethiopian tradition where 'races and ethnic groups had for centuries been inextricably mixed and blended in unity' and, in effect, repudiate "the ideology of… 'Greater Ethiopia'" (*VE*, p. 47; 165; 184. Much of this is valid, yet open to distortion and exaggeration. Few will deny available statistics on arbitrary decisions, harassment of journalists and the political opposition, detention without trial and extra-judicial killings under EPRDF watch. On the other hand, the pre-1991 Ethiopia in which Eritrean, Tigray and Oromo élites took up arms against the central authority is *not* an epitome of unity, only a society at risk from self-destruction. For Tronvoll, ethnic federalism does deconstruct old Ethiopia, but it was also necessary to re-constitute the body politic following the collapse of imperial-type centralization.

This suggests two general points. First, regardless of the mode of acquiring state power, an incoming administration has much of its work cut out for it by its predecessor. Second, there is more to EPRDF's reform program than opportunistic restructuring. The 1994 constitution not only "represent[s] a clear *breach* with former Ethiopian Constitutions," but also that federalism was about the only mechanism by which to keep Ethiopia together as a single unit after Eritrea attained *de facto* independence in 1991 (*TE*, p. 18-19). Many of the difficulties Vestal ascribes to EPRDF thus come across, in Tronvoll's analysis, less as intended effects than problems in managing structural change in circumstances where nearly all key players are at sea or blinded by self-interest, and politics-as-activity and mutual trust are uncommon currency (*TE*, p. 16-17; 20-22). Vestal agrees that Ethiopia lacks traditions of limited and accountable government and of participatory politics (*VE*, p. 45; 87; 89). Still, his analysis of the Constitution suggests the EPRDF could have made the quantum leap to liberal-democratic practice in a few years – despite its own military antecedents and threats of violence by the opposition (*VE*, p. 32).

So which way the Ethiopian transition? Both authors are cognizant of the international influence on Ethiopia, but internal social dynamics are no less critical. Vestal urges disaffected groups such as the Oromo to "avoid" the secession-unity dialectic in favor of inclusive discourse (*VE*, p. 203). His basic prescription though, is that the US re-assess its hand-in-gloves position: tighter aid conditionality, and constructive engagement with human rights and democracy activists must be applied to EPRDF, as they have to China and Sudan. There also is a moral case for greater US involvement in Ethiopia,

…where generations were taught by dedicated American teachers or worked in U.S.-led businesses; and where many Ethiopians, when forced to leave their homeland, demonstrated their affinity for the United States by going there to live in far larger numbers than any other place. Ethiopians literally have voted for the American way with their feet. For such trusting friends, must the United States continue to look the other way when Ethiopia's rulers make a mockery of democratic processes and commit gross indecencies against their people (*VE*, p. 197-198)?

Perhaps not. However, Ethiopia is also an important bridgehead for US interests in the African Horn, where national sovereignty still evokes considerable passion. As such, US preferences by themselves are hardly sufficient grounds to expect a policy reexamination in Addis Ababa.

For example, the EPRDF response to international pressure for economic reform has deepened its domestic clout. Vestal appends a list of business ventures owned or controlled by the ruling coalition, apparent results of a privatization program by which EPRDF elements have been buying with the left hand, what the state it controls has been privatizing with the right. However, the list also illustrates EPRDF is "serious" in its commitment to market-based reform (cf. Ottaway 1999, p. 73-77), and hints at the making of a new capitalist bourgeoisie in Ethiopia whose elements might one day encourage further political liberalization. In the meantime though, state power remains central to economic relations; difficult decisions remain to be made on property relations in land, and the economic implications of formal equality granted to all ethnic-regions. Since unequally endowed entities *cannot* realistically compete on the same terms, Ethiopia unwittingly might be creating a climate that entrenches group inequality, encourages a new hierarchy of groups, or even denies that minorities *do* exist (*TE*, p. 19; 22-23). Ethiopia's transition to modern statehood, it seems, has a long way yet to go.

Together *A Post-Cold War State in Africa* and *A New Start* illustrate two unexplored themes on Ethiopian studies: how bewitched and/or divided scholars and observers of Ethiopia can be by disparate constructions of their subject, and the costs in unrealized political as well as analytic capital, of visual-conceptual categories from epochs gone by. Vestal's concern for what EPRDF has *not* done to restore the *status quo ante* is so overwhelming he glosses over the turmoil in Ethiopia's immediate past, as well as the law of cumulative incrementalism, by which change takes place as a small, additive process. Tronvoll in turn points to several important attributes of a reform program that, despite its shortcomings, has created a new climate for non-violent political interaction. Surely EPRDF has benefited from Ethiopia's situation, but self-aggrandizement by sitting régimes is invariably part of institution building. Without it hegemonization would lack variable political content. Vigorous opposition is equally important nonetheless: by checking abuses and focusing the popular imagination, opposition groups might well energize the quest for a new élite settlement. Ethiopia's first steps in that direction, it seems, must include further elaboration of existing mechanisms to redress perceived deficiencies and create an environment more conducive to shared political and organizational spaces.

Works cited

Kuhn, Thomas S. 1962 [1996]. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Ottaway, Marina. 1999. *Africa's New Leaders: Democracy or Reconstruction?*. Washington, D.C.: Carnegie Endowment for International Peace.

Sorensen, John. 1993. *Imagining Ethiopia: Struggles for History and Identity in the Horn of Africa*. New Brunswick: Rutgers University Press.

Olufemi A. Akinola
Harvard University

State Legitimacy and Development in Africa. Pierre Englebert. Boulder: Lynne Rienner, 2000. 244pp.

In *State Legitimacy and Development in Africa,* Pierre Englebert directly links the developmental capacity of African states to their level of legitimacy. He contends that Africa's overall developmental incapacity springs from states' illegitimacy, which he sees as endemic throughout the continent. Similarly, the author accounts for Africa's successful nations by pointing to their relative legitimacy.

Englebert begins by highlighting the exogenous origin of most African states and the concomitant disruptions of colonialism that disconnected African peoples from their political and economic institutions. The state structures and boundaries created by colonial powers and post-colonial leaders bore little resemblance to those that preceded colonialism. The states and their leaders were therefore illegitimate, according to Englebert. Consequently, he argues, illegitimate African leaders have been forced to bolster their power through ineffective policies such as rent-seeking and neo-patrimonialism.

Not all African countries, however, have suffered this fate. Englebert shows that the most economically productive African states, e.g., Botswana, Mauritius and the Seychelles, are also the continent's most legitimate states. Their leadership and political boundaries, he argues, are embedded in the history and culture of the country. Therefore, their leaders do not need to maintain political power at the expense of development. It is this historical legitimacy that separates these successes from economic disasters like the Democratic Republic of Congo and Somalia. Herein lies the book's greatest strength; while most authors who attempt to explain African economic failure pay little attention to the continent's successes, Englebert's theory explains both success and failure in Africa as two sides of the same coin. Legitimacy leads to success while illegitimacy leads to failure.

Englebert's comparison of the Congo and Botswana beautifully illustrates the historical peculiarities that have given these two countries drastically divergent paths over the last thirty years. While civil war and a deteriorating economy have engulfed the Congo since independence, Botswana had the highest economic growth rate in the world from 1960 to 1985. Englebert shows that Botswana's massive diamond reserves alone did not stimulate the country's growth. Rather, good governance and good policies allowed the Botswana government to utilize their diamond reserves as a springboard for economic takeoff. The Congo's richness in diamonds, copper, cobalt, zinc and gold has not propelled the Congo to wealth or even stability. "If Botswana's miracle is one of natural resource endowment," Englebert argues, "then it should have been dwarfed by development in Congo (p. 106)." Poor policies and governance in the Congo did not allow that to happen.

But what explains these distinct paths? Again, Englebert argues that legitimacy is the crucial difference. While Belgian colonial leaders carved out the Congo with no concern for local political and cultural realities, Botswana's limited form of colonial rule did far less damage to its political and social continuity. This continuity, or legitimacy, has enabled Botswana to escape the "politics of illegitimacy" so common throughout Africa (p. 97).

Englebert furthers his argument with an impressive, though at times esoteric, quantitative analysis of the effects of legitimacy worldwide on development. He uses a variety of statistical methods to show the correlation between state capacity (i.e. good governance and good policies) and economic growth. While Englebert understands that legitimacy is not the only determinant of development, he clearly believes that it plays a crucial role.

Englebert's work fits within the existing literature on the state in Africa and political economy. Thus, his argument is heavily grounded in the theories of Crawford Young and Peter Ekeh, both of whom stress the imported nature of the African state, and those who have analyzed the ineffective policies of African leaders, such as Catherine Boone and Robert Bates.

Perhaps the most unique aspect of this book lies in Englebert's conclusion that the sanctity of the African state must be questioned. If Africa's intrinsic defect is its preponderance of illegitimate states, Englebert asks, why doesn't the international community reconsider state boundaries in Africa? Initially, this sounds far-fetched and radical. Perhaps Englebert does go too far here. The re-arrangement of state boundaries anywhere, let alone in as ethnically diverse and politically complex a place as Africa, would be fraught with myriad problems. Should the many Tswana-speakers in South Africa become assimilated into Botswana, for instance, or would this simply undermine Botswana's successes? Clearly, the problem is not simple. But, as Englebert points out, Somalia, Congo and other African states have already unraveled and others are bound to follow. Holding fully to the sanctity of illegitimate borders makes as little sense as carelessly ridding the continent of those boundaries.

Because Englebert's work draws from the political economy literature, political scientists and development workers will find the book to be of great interest. Africanist historians will also see the merit of his work, as it is, fundamentally, a historical argument of development and underdevelopment. This book's combination of rigorous analysis and clear prose make it a wonderful addition to the present literature on African affairs.

Brendan McSherry

Do I Still Have a Life? Voices from the Aftermath of War in Rwanda and Burundi. John M. Janzen & Reinhild Kauenhoven Janzen. Lawrence: University of Kansas, 2000. Pp. 234.

The title and publication date of "Do I Still Have a Life?" may suggest that this book deals with the situation in Rwanda and Burundi a few years after the respective tragedies of 1994 and 1993. For anyone interested in the current situation in both countries, this would be an exciting prospect. In Burundi, due to ongoing low to medium intensity conflict, it has been nearly impossible to carry out any ethnographic work over the last few years. This has also been the case in Rwanda. Since the return of the refugees at the end of 1996, the possibilities for conducting fieldwork among rural and ordinary populations inside Rwanda have been extremely restricted. For this reason, researchers have a very limited understanding of how people have resumed their lives and are now coping in the years immediately following the tragedy.

The fieldwork for this book was carried out over a two month period from the end of 1994 to the beginning 1995. At that point, it was still relatively easy to carry out fieldwork due to the fact that there were over 150 international relief agencies in the region. The authors were recruited by the Mennonite Church to provide analysis and philosophical reflection on the situation in the Great Lakes and to listen to individual stories. This gave the authors access to vast networks, which allowed the authors to discuss events with people freely. Indeed, many people were very eager to tell their stories; this situation has changed dramatically since then. Following their fieldwork, the authors have continued their work by following up on some individuals through correspondence in order to cross-check divergent accounts of certain events and learn about the complicity and participation of certain individuals they interviewed. *Do I Still Have a Life?* has clearly been put together with a lot of reflection and commitment, and thus is, in this sense, a quite remarkable book.

This book is an ethnography, focusing on individual experiences of the war and genocide in Rwanda and Burundi, but it differs from the majority of existing testimonial anthologies in three fundamental ways.[1] First of all, other works have mostly focussed on genocide survivors, while the Janzens' have tried to collect as many different perspectives as possible (visiting both the camps in Zaire and localities inside Rwanda and Burundi). They have opted to give voice and agency back to the individual characters in the wider tragedy, without objectifying individual choices and actions. Moreover, they believe that

despite the important place of writings...that suggest that the events surrounding the genocide and a war can be understood by careful historical reconstruction and disciplinary analysis that is rationally understood, our point of departure is that many of the individuals whose stories we heard reflect the fundamentally irrational and incomprehensible nature of war, on the part of both those who were involved in it and those who observed it from the outside....Therefore there is a need to listen to the voices to examine the many complex ways that rationalities and irrationalities interact in the lives of individuals, their communities and their families.[2]

Secondly, the authors do not just focus on people's experiences during the war, the genocide and life in the refugee camps, but have opted for broader life histories. As such, they are able to grasp Rwandan and Burundian society in all its complexity and contradictions. A stereotypical and overly simplistic Hutu vs. Tutsi approach was purposely avoided, which constitutes a laudable accomplishment making for a refreshing read. Finally, simply recounting testimonies is not the main aim of the book. Instead, the stories are used to gain deeper insight into topics such as the role of ethnicity, healing, reconciliation and justice (which are further elaborated in part II).

The book is written with clarity and academic seriousness, giving careful thought to methodological questions and ethical dilemmas with respect to fieldwork. The material is presented in an extremely accessible manner that is bound to appeal to a much wider audience beyond the often small circle of academics directly concerned with Rwanda and Burundi. It is richly illustrated with drawings and photographs, including for instance a section on drawings of children and their visual memories of peace and war. Unfortunately, the book only includes one general map of the region. It would have been helpful to reconstruct the route the Janzens took during their research in Zaire, Rwanda and Burundi. Those who are interested in grand theories or the final explanation for the Great Lakes tragedy will be disappointed. Readers interested, however, in the reflections of ordinary characters in this unfolding drama and the realistic options for post-war healing and social reconstruction at the local level will find a wealth of material to ponder. Despite the focus on Rwanda and Burundi, those working in different (post-) war zones on the African continent will undoubtedly find relevant material for comparison in *Do I Still Have a Life*.

Saskia Van Hoyweghen
Brussels Centre of African Studies
Vrije Universiteit

Notes

1. For example, African Rights, "Rwanda, Death, Despair and Defiance," London: African Rights, 1994; Phillip Gourevitch, "We Wish to Inform You That Tomorrow We Will be Killed with Our Families: Stories from Rwanda," New York: Farrar, Strauss & Giroux, 1997.
2. John M. Janzen & Reinhild Kauenhoven Janzen, "Do I Still Have a Life? Voices from the Aftermath of War in Rwanda and Burundi", Publications in Anthropology N°20, Lawrence: University of Kansas, 2000, p.3.

State, Civil Society and Apartheid: An Examination of Dutch Reformed Church-State Relations. Tracy Kuperus. New York: St. Martin's Press, 1999. Pp. 211.

State, Civil Society and Apartheid in South Africa: An Examination of Dutch Reformed Church-State Relations, a dissertation that has been turned into a first-rate book, will appeal to both political scientists and historians of religion, especially those interested in South Africa. Although Kuperus' primary conclusion that institutions of civil society do not necessarily prompt greater democratization of the state is hardly a surprising one, the way she carefully analyzes the changes within the Dutch Reformed Church (Nederduitse Gereformeerde Kerk, or the NGK) and its influence on the South African government over a sixty year period (1934 to 1994) is a welcome contribution to the scholarship on church-state relations in 20th century South Africa.

In analyzing possible church-state relations, the author constructs a theoretical model that outlines six potential typologies that characterize this relationship. At one end of the continuum resides extreme cooperation, while at the other is extreme conflict. The main points identified by Kuperus in her model are cooptation/collaboration, mutual engagement, balanced pluralism, coexisting conflict, conflictual resistance and enforced disengagement.

Kuperus argues that the period from 1934 to 1947, when the United Party controlled the government, was one of coexisting conflict beween the government and the NGK. When the National Party came to power in 1948, this relationship shifted in tone to one of mutual engagement. Collaboration marked the period from 1962 to 1978 when official interaction and collusion between the state and the church was so strong that the two institutions "became almost indistinguishable" (p.154).

The relationship that existed between the church and state from 1979 to 1994 was typified by mutual engagement. Contrary to the conventional view, which holds that the church pressured the state to dismantle apartheid legislation, lift the ban on the ANC and other political organizations and release Nelson Mandela, Kuperus argues that the church lagged behind the state with regards to liberalization during this period. She writes,

in the end, the church's position differed from positions held by state leaders who were willing to revise the directives of separate development for the purposes of white survival and economic prosperity. This situation revealed the NP-dominated state moving ahead of a societal institution like the NGK on reform and democratization (p. 151).

Her explanation is that the NGK "could not easily distance itself from the moral and biblical underpinning of apartheid that it helped to construct" (p. 129). However, there were also pragmatic reasons behind the NGK's resistance to change. When the National Party embarked on reforms in 1982, conservatives within the organization broke off to form the Conservative Party. In an effort to avoid a schism within its denomination, the NGK "took a more moderate stance on the issue of reform than state leaders were promoting" (p. 132). Despite this effort to maintain unity, there was a breakaway of conservative parishioners from the NGK to the newly formed Afrikaanse Protestante Kerk in 1986.

Kuperus concludes with some remarks on the progress the NGK has made in the last 15 years to distance itself from the "theology of apartheid" it created, to apologize for the pain it caused millions of people and in its attempts to seek more inclusive arrangements within Reformed institutions (p. 159). Having read this book after following the testimony of the NGK at the Truth and Reconciliation Commission's (TRC) faith community hearings, I do not draw the same sanguine conclusions as the author does about the NGK's sincerity of apology or its commitment to greater church unity with nonwhite congregants. For example, the NGK still has not united with the "daughter," or Coloured and African churches. Unfortunately, Kuperus only refers briefly to the TRC (see p. 159) and not at all to the faith hearings, which are rather large gaps in the book's account of events. Given the lag time necessary for academic publishing, however, it is possible that these hearings (November 1997) came too late to be included in this book. Despite the absence of the TRC and faith hearings in Kuperus's analysis, the book still presents an interesting and compelling account of the NGK's role in the overturning of South Africa's apartheid state.

Lyn Graybill
University of Virginia

Textual Politics from Slavery to Postcolonialism: Race and Identification. Carl Plasa. New York: St. Martin's Press, 2000. 172pp.

Carl Plasa specifies in the introduction to *Textual Politics* that the book focuses on a wide variety of literature: works from diverse cultures, historical periods and "racial" perspectives. He states that the breadth and diversity of the source material is both deliberate and important because "the inscriptions of racial crossing with which the book deals themselves participate in larger networks of transhistorical and cross-cultural dialogue, revision, interchange and contestation" (p. 3). With this in mind, Plasa developed a study that crosses a wide range of cultures. He interprets work such as *The Interesting Narrative of the Life of Olaudah Equiano* by Olaudah Equiano (1789); *Mansfield Park* by Jane Austen (1814); *Jane Eyre* by Charlotte Bronte (1847); *Wide Sargasso Sea* by Jean Rhys (1966); *The Bluest Eye* by Toni Morrison (1970); and *Nervous Conditions* by Tsitsi Dangarembga (1988).

Some readers, however, might consider the almost two hundred year span to include too many literary and historical time periods to adequately cover. Others might take issue with the way Plasa moves from Iboland (in present-day Nigeria) to England to the Caribbean to the United States and finally to Zimbabwe. Nonetheless, this discursive approach notwithstanding, the theoretical perspective and the focus on identity and cultural identification unify the text specifically and strategically to render the ambitious scope manageable.

Plasa draws extensively from Homi K. Bhabha and Frantz Fanon for the postcolonial theoretical perspective to unify his analysis of the texts, with excursions into the fields of feminism, deconstruction and psychoanalysis which help him develop more thorough readings of the texts under discussion. Because Plasa is dealing almost exclusively with novels written by women, one wonders why he has not chosen the works of postcolonial feminists such as Gayatri Spivak, Hortense Spillers and Amina Mama as additional works for his analysis. However, identity and identification have historically been associated with the male persona. Thus, when Plasa contextualizes both the works under study and his analysis of them, it is within the larger political arena of male identity that all must operate.

Indeed, Plasa configures this male identity from the beginning, with his initial essay about Olaudah Equiano and his search for identity and the power of self-definition. In this chapter of *Textual Politics*, Plasa provides the reader with an analysis of the literary discourses available to Equiano through which he could construct himself and the narrator of his text, which is simultaneously a slave narrative, an autobiography, a political treatise, a coming of age story and a picaresque adventure-quest. In crossing all these genre “boundaries,” just as he crosses multiple political, economic and religious markers, Equiano presents himself, argues Plasa, as “a black subaltern who figures himself as a white colonizer/imperialist,” while at the same time exploring his essence as a Christian convert (p. 31). Equiano uses this crossing-over technique, he further suggests, to blur the binary oppositions (such as white-black, colonizer-colonized, and master-slave, among others) that were the foundation of Western peoples’ notions of themselves and the world. In this process, Plasa points out, Equiano demonstrates “the inessentiality of race as a marker of difference,” driving home the fact that European fortunes, European notions of world order and European political systems were built on illusions.

In his four middle chapters on the development of female characters and female identity in *Mansfield Park*, *Jane Eyre*, *Wide Sargasso Sea* and *The Bluest Eye*, Plasa spans over a hundred years and three different areas of the globe. However, all of these places and time periods are connected by the Atlantic Ocean, the slave trade and the colonizing forces of European males. Plasa’s analysis of the construction of the identity and self of the women characters are necessarily intertwined, since periods of history are never discrete. Moreover, the various cultures that these books represent can never be "hermetically sealed off from one another"; instead, they must be analyzed and absorbed as "elements in a constantly shifting network of relations, responses, crossings and hybridities” (p. 99).

In the final chapter, Plasa draws together the texts and eras under discussion (and others such as *Coriolanus* by Shakespeare) in an analysis of the relationship between Tsitsi Dangarembga's *Nervous Conditions* (1988), Frantz Fanon's *The Wretched of the Earth* (1961), and Charlotte Bronte's *Shirley* (1849). He indicates in this chapter that, not only does Dangarembga position her text within a Fanonian frame of reference, but she also "extends and revises [it] from a black feminist perspective" (p. 122). Plasa also specifies that both Dangarembga and Bronte locate the ability to control and define self in the heroines of their novels in the women's control over their bodies. Dangarembga forces this issue of control and self-definition one step further, though, when she presents a young Zimbabwean girl as anorexic.

Women's identity, then, in the face of the Fanonian male frame of colonialism and the colonial powers' dictation of what and who their colonial subjects could be, is developed and explored as a reaction to control. Because women are valued in male systems only for their reproductive and nurturing functions (that is, because they can produce and take care of families), the locus of their identity rests in their bodies—body, not mind, spirit, or soul, establishes who and what a woman is. Nyasha, one of the main characters of *Nervous Conditions*, like Caroline and Shirley of *Shirley*, define themselves by controlling the only aspect of their identities that they thought open to women—their bodies. As Plasa points out, though, Dangarembga is crossing boundaries with this depiction of an African girl with anorexia, for she thus "challenges the Western feminist consensus that anorexia is a disease typically afflicting the white middle-class female subject," (p. 130). Such crossings, as Plasa has so aptly demonstrated, have been a mainstay in the literature of women and the colonized for two centuries.

Textual Politics from Slavery to Postcolonialism: Race and Identification is a valuable addition to the growing body of secondary literature centering on slavery, colonialism and postcolonialism as they are evidenced in literary texts. Although he is using sophisticated, sometimes dense literary and cultural theory to analyze diverse works of literature, Plasa is eminently readable and always thought-provoking. This text is appropriate for advanced undergraduates, graduate students and other scholars in postcolonial and literary studies.

Samantha Manchester Earley
Indiana University Southeast