LEGUME DIVERSIFICATION TO IMPROVE SOIL FERTILITY

Location: Ekwendeni, Malawi

Unlike conventional "top down" technology transfer extension models, the success of this legume diversification project underscores the importance of participatory research and extension methodologies to address the complex social factors—community needs, gender dynamics, access—that influence new technology adoption in agriculture.

CHALLENGE

Malawi is a landlocked country in southeast Africa with a population of more than 16 million people. The largely agricultural economy employs 90 percent of the people.[1] Maize is grown by 97 percent of farming households and accounts for approximately 60 percent of total national caloric consumption.[2] Abandonment of traditional bush fallows, combined with decades of intensive cultivation and variable annual rainfall, has led to widespread soil depletion, repeated nation-wide food shortages, and chronic malnutrition.[3] Over 50 percent of Malawi's farmers produce yields below subsistence levels, while only 20 percent are able to produce consistent marketable surpluses.[4]

In Malawi, the high reliance on maize production by food insecure subsistence farmers is a key constraint to sustained agricultural productivity. Cereal crops deliver high caloric value with moderate labor inputs, but continuous cropping without significant organic inputs like animal manures, compost, or nitrogen-fixing legumes can rapidly deplete soil organic matter reserves and important plant nutrients, including nitrogen and phosphorus.[5] Long-term soil deterioration from continuous maize cropping results in continuous declines in productivity and growing hunger.[6]

Successive government subsidy programs supporting the purchase of inorganic fertilizers have contributed to sustain yields for most farmers in Malawi. However, despite short-term yield gains, synthetic fertilizer application can negatively affect soil and environmental quality and exacerbate the problems of low nutrient holding capacity, high acidity, low organic matter, poor soil structure and low water-holding capacity, all of which currently constrain smallholder productivity in Malawi.[7] In addition, when it is not subsidized, synthetic fertilizer is prohibitively expensive for most Malawian farmers.[8]

Nitrogen-fixing cover crops, or "green manures," and edible legumes have long been promoted as an important strategy for enhancing yields, promoting human nutrition, and conserving soil quality in low-input smallholder farming systems.[9] However, subsistence farmers in Malawi produce few legumes and the use of these crops is steadily decreasing.[10] Resource poor farmers are willing to grow legumes, but labor requirements, limited access to appropriate seed varieties, uncertain markets, and limited technical education are barriers to more intensive legume uptake.[11]

RESPONSE

In 2000, the Ekwendeni Hospital launched the Soils, Food and Healthy Communities (SFHC) Project. Designed to address food insecurity and low soil fertility in the villages surrounding the town of Ekwendeni, the initiative brought together researchers from the University of Western Ontario and Michigan State University. Educational activities and participatory research were conducted with 80 separate agricultural communities. Farmers were provided with information about the impact of edible legumes and leguminous cover crops, which are uniquely suited to enhance soil quality and human nutrition. These cover crops replenish and enhance nitrogen and recycle important nutrients like phosphorous that are crucial to productivity,[12] while providing protein and iron-rich seeds and foliage for human consumption.[13] Communities also learned about management, marketing opportunities, and the ability of legume diversification to suppress pests.

A participatory research model was used where farmer-researcher teams (FRT) were formed with representatives chosen by villagers to provide more information about the management options of the legume technologies. In this 'horizontal' model of research and extension, the FRT helped conduct applied research for the larger community based on the specific needs, interests and norms of the population to be served. Five different legume technologies (including seed) were offered to farmers based on earlier diversification research in central and southern Malawi as follows: groundnut (peanut) and pigeon pea intercrop (year one) rotated with maize (year two); soybean and pigeon pea intercrop (year one) rotated with maize (year two); maize and pigeon pea intercrop; *Mucuna* cover crop rotated with maize; and *Tephrosia vogelii* relay intercrop with maize.

The FRT developed an improved cropping model: farmers typically coppiced pigeon pea (cut the plant back to the main stem after harvest which encourages regrowth and a higher yield in the second year), intercropping the two-year-old plants with maize the following year, thereby growing grain legumes two years in a row, or 'doubled-up grain legumes' (DGL). This farmer innovation provided large amounts of legume residue for soil fertility improvement, while at the same time ensured production of three nutrient-enriched legume crops in conjunction with a maize crop.

A farmer-to-farmer teaching model was implemented, allowing farmers to participate in field days and to work with more experienced peers. A "mother-baby" strategy was used to educate about the management of all the legume technologies used in the study. In each participating community, trials of all five legume options were grown in central village plots maintained by the FRT to allow direct observation by farmers (i.e. the "mother" plot). Individual farmers simultaneously tested one to two of the legume options in "baby" trials (10x10 meter plots) at their home and compared them to their normal cropping systems. All farmers were instructed to plant their chosen legume technology at uniform planting spacing or density.[14]

Chilida village area experimenting group, with their harvest of finger millet. © Rachel Bezner Kerr

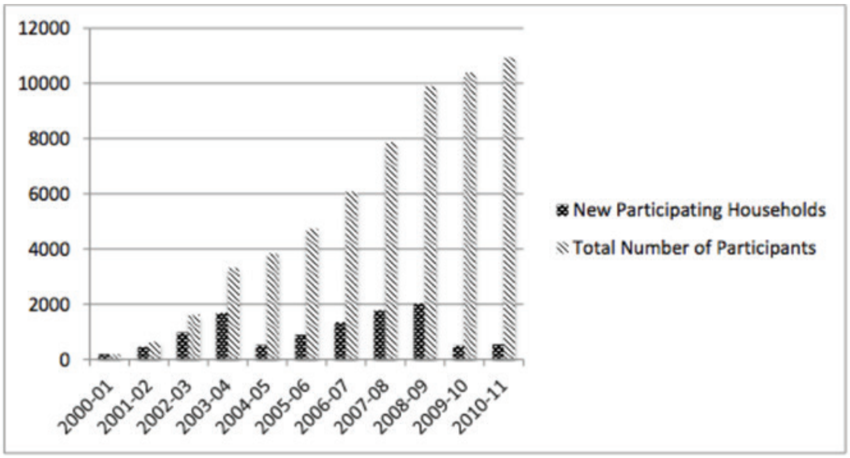
Incorporating crop residues–as opposed to burning, the traditional practice–can have a significant impact on the soil quality benefits of legume cropping. Early incorporation of green manures or edible legume (after seed harvest) biomass is known to derive the greatest soil fertility benefit.

Depending on growing conditions, legume options contributed between 30 and 90 kilogram of nitrogen per hectare per year, which helped increase maize yields and led to food security and dietary diversity improvement.

RESULTS[15]

From 2001 to 2005, more than 3,700 farmers tested one of five different legume technologies in their cropping systems, and women's participation in the project increased from 29 percent in 2001 to more than 50 percent in 2005.[16] Total number of participating households greatly increased as project results became more popular in the country. By 2011, over 10,000 farmers had joined the project (Figure 1).

Figure 1: Total number of SFHC participants and new participating households



- Experimentation and adoption of legume technology was fostered among even the most resource-poor farmers. The most favored legumes were edible food crops (notably pigeon pea and groundnut), as these options provided dietary and income supplement on top of improving soil fertility. Surveys could note gender differences in choice of crops, with women preferring edible crops and men choosing more often crops with market value.
- Participating households fed significantly more edible legumes to their children compared with control households. More that 50 percent of project participants who grew pigeon peas and groundnuts reported feeding their children legumes daily or several times each week.[17]
- A 2009 survey of 128 SFHC farmers showed that average area planted with intercrop of pigeon pea and groundnut had expanded from 389 square meters (m^2) before the project to 1,832 m^2 by 2009 (over a four-fold expansion). Pigeon pea and soybean intercrops followed the same trend, with an increase from 345 m^2 to 1,893 m^2 by 2009.
- Increase in crop diversity was achieved, with farmers participating in the project growing on average 2 or more crops than others, in general legumes or crops better adapted to climatic conditions, like cassava and sorghum.

Jessie Kaunda standing in her pigeonpea and groundnut field. © Carmen Bezner Kerr

Crop rotation is the practice of growing a series of dissimilar types of crops in the same area in sequential seasons for various benefits such as to avoid the buildup of pathogens and pests that often occurs when one species is continuously cropped. Crop rotation also seeks to balance the fertility demands of various crops to avoid depletion of soil nutrients.

Addressing gender inequality: Margaret Shonga's husband is holding the child in their maize field. © Rachel Bezner Kerr

Farmers discussing field observations, Kabwanda. © Carmen Bezner Kerr

- Depending on growing conditions, legume options contributed between 30 and 90 kilogram of nitrogen per hectare per year, which helped increase maize yields and led to food security and dietary diversity improvement.
- The FRT grew from an initial 30 members to over 100 members in 2011. FRT played a crucial education role conducting ongoing trainings and education, touching on a variety of subjects such as improved legume residue management (e.g. incorporation vs. burning): 72 percent of farmers reported burying legume residues in 2005 compared to 15 percent in 2000.[18] As the project evolved, the FRT improved cropping models to produce higher amount of crop residues and improve soil fertility as well as provide diversity of nutrient-enriched legumes. Additionally, the FRT educated households on climate change, managed a community legume seed bank, and conducted great project evaluation, monitoring farmer participation in trials and preference for legumes.

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ENDNOTES

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FRONT PAGE PHOTO:

Mrs. Isobel Chirwa standing in her pigeonpea field intercropped with several nitrogen-fixing shrubs.