Gender Analysis of a Nationwide Cropping System Trial Survey in Malawi

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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

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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.

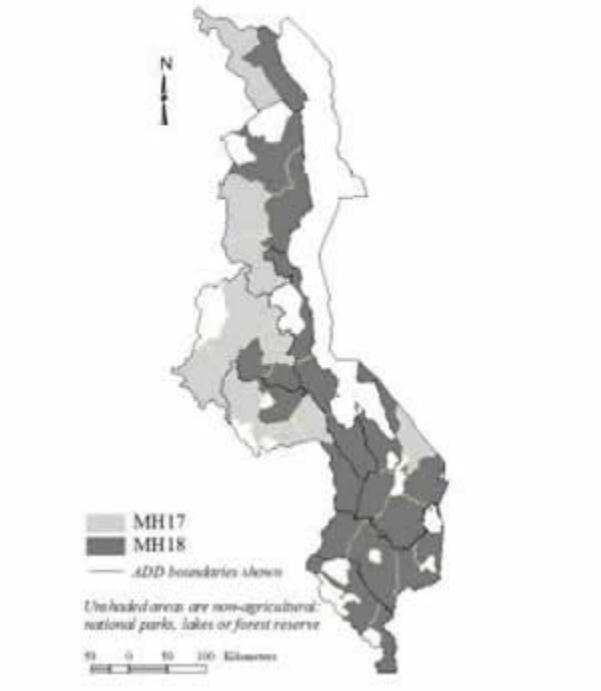

Figure 1. Map of agroecological zones in Malawi in which MH17 (high altitude) and MH18 (low-medium altitude) maize cultivars were used.

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).

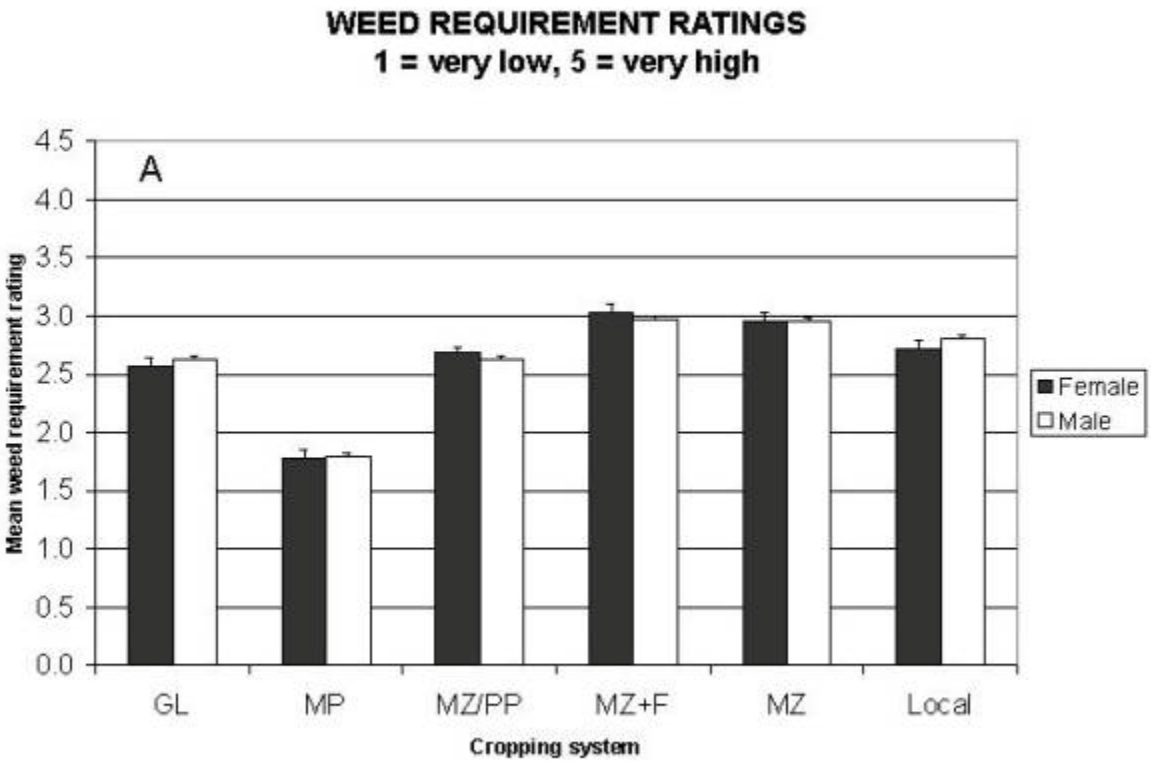

Figure 2 A (above): Weed requirement ratings of the 6 cropping system treatments

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]

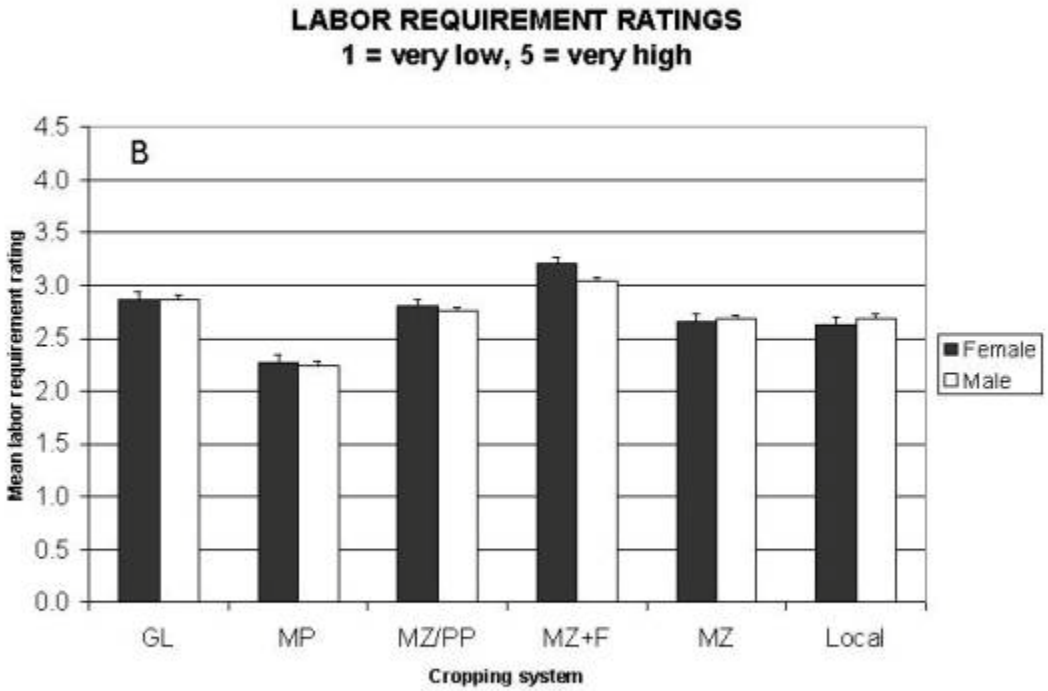

Figure 2 B (above): Labor requirement ratings of the 6 cropping system treatments

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.

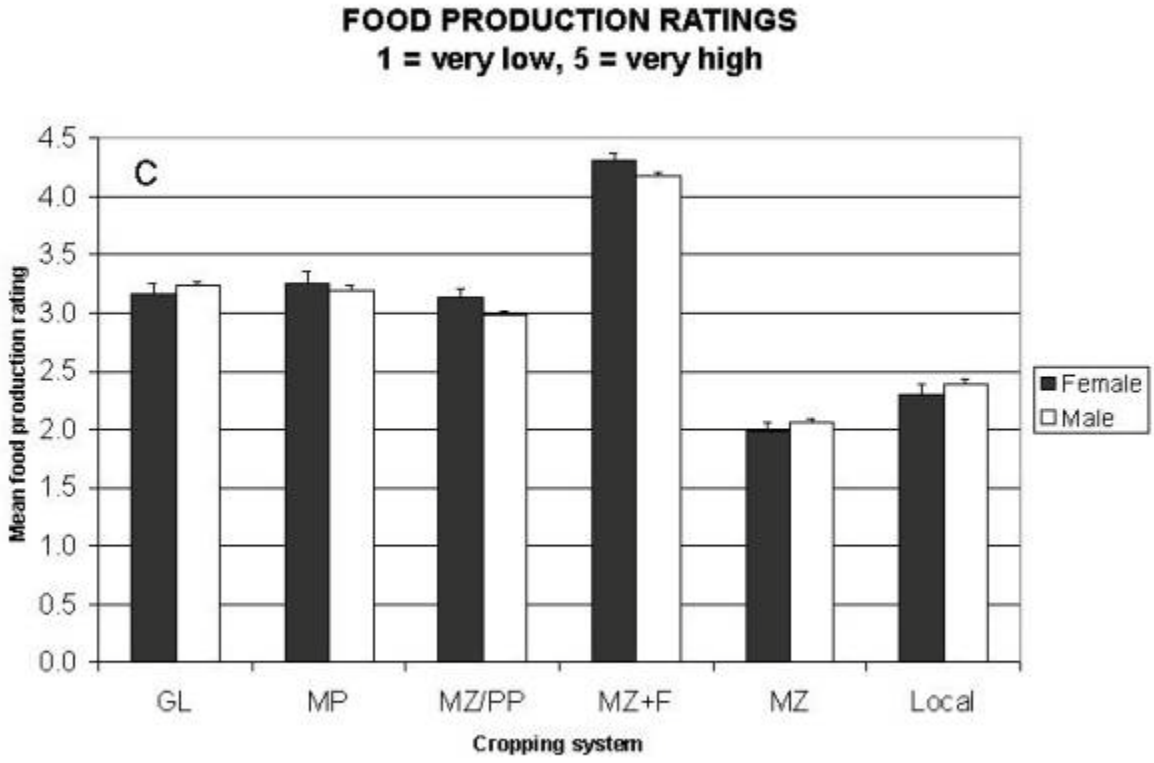

Figure 2 C (above): Food Production ratings of the 6 cropping system treatments

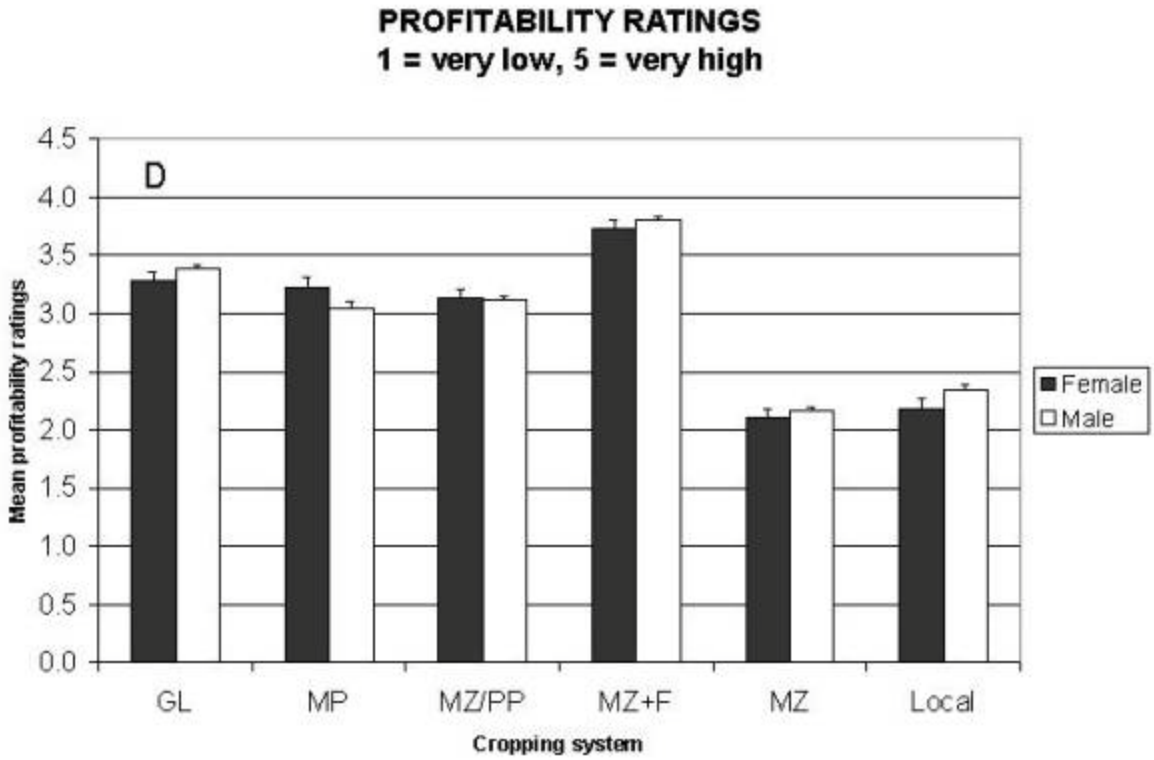

Figure 2 D (above): Farmer-estimated profitability of the 6 cropping system treatments

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.

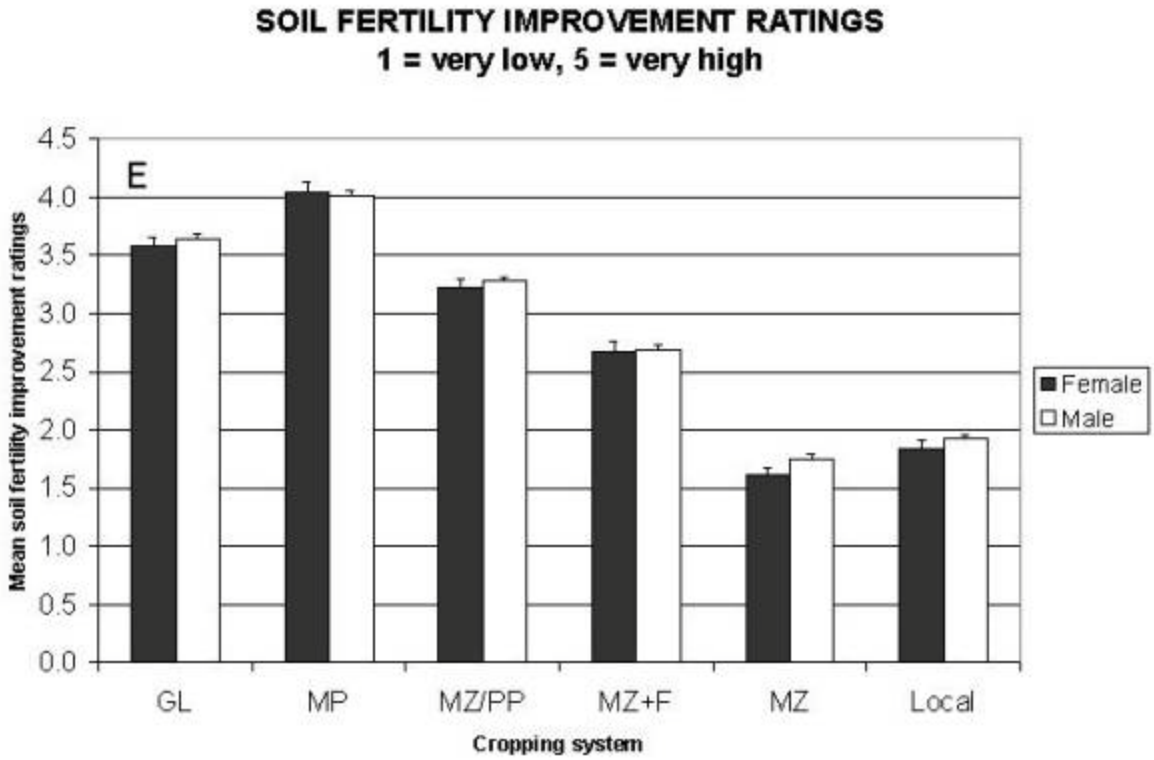

Figure 2 E (above): Farmer-estimated soil fertility ratings of the 6 cropping system treatments

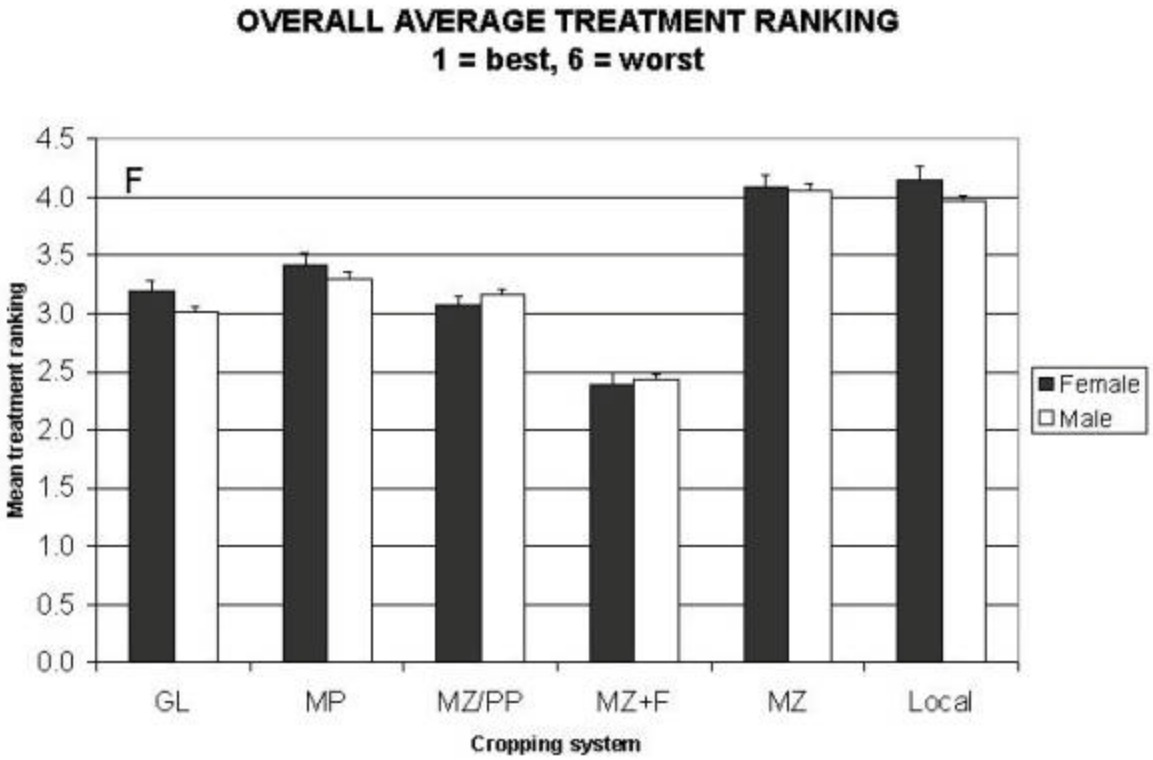

Figure 2 F (above): Overall ratings of the 6 cropping system treatments

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)

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