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Gender and Intra-Household Use of Fertilizers in the Malawi Farm Input Subsidy Programme*

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Abstract

The Farm Input Subsidy Programme targets households for subsidized farm inputs, and usually it is the head of the household who receives the coupons. Since households tend to have multiple plots which are controlled by different members of the household, there may be intra-household issues that arise in the use of farm inputs available to the household. We find that while male-headed households are more likely to receive coupons than female-headed households, there seems to be less bias in intra-household use of subsidized fertilizers (or fertilizers in households receiving subsidy) between plots controlled by female and male members. This is despite the fact that, more generally, household incomes from various sources tend to be controlled and allocated by men. It also contrasts with evidence that plots controlled by female members were less likely to be applied with fertilizers when we consider all fertilizers in subsidized and unsubsidized households.

Keywords: Malawi; Agricultural Subsidies; Gender

1. Introduction

Gender equality and women's empowerment are increasingly recognised as an integral aspect of development alongside central policy objectives such as the achievement of Millennium Development Goals. There is a large and growing literature on resource allocation processes within households and the associated gender dimensions. Çağatay and Ertürk (2004) argue that social inequalities, including those based on gender differentiation, hamper the development process and dampen economic growth. According to Senguino (2000) the state of gender relations is readily observable in several economic arenas: a) job segregation within the paid labour market, b) the division of labour between paid and unpaid labour, c) the distribution and control of income and resources within the household, d) access to the distributions by the state, such as access to education and social safety net programmes, and e) credit in financial markets. The effect of gendered economic opportunities is such that the pattern of benefits is extremely skewed with men continually – either directly or indirectly – obtaining much of the credit, monopolising contacts with extension agents and more likely to have access to scarce production inputs such as fertilizer (Sender 2003).

Questions about gender issues and household resource allocation also arise in the Farm Input Subsidy Programme (FISP) implemented by the Government of Malawi, that has been in place since the 2005/06 agricultural seasons. FISP is designed as a targeted input subsidy programme, targeting smallholder farmers with land but who cannot afford to purchase inputs at market prices. The main objective of the programme is to raise the income of smallholder farmers through improvements in agricultural productivity and food security. The size of the FISP rose from 132,000 tonnes of subsidised fertiliser in 2005/06 to 216,000 tonnes in 2007/08 and has since fallen back to 160,000 tonnes in 2009/10 (Dorward and Chirwa 2010).

This paper attempts to investigate the gender differences in the application of fertilizers in general and subsidized fertilizers in particular, on plots controlled by male and female household members. We utilize quantitative and qualitative data collected in the 2009 Agricultural Input Subsidy Survey (AISS2) covering the 2008/09 agricultural season. We basically test two hypotheses. First, we test whether there are gender differences in the use of available fertilizers regardless of type of acquisition (hence, commercial and subsidized fertilizers) by plots controlled by female and male members of the households). Second, we test the same hypothesis except that we focus on households that had access to subsidized fertilizers only – those that did not acquire commercial fertilizers. The paper is organized into five sections. In the next section, we highlight the theoretical issues in household decision making in relation to the design of the subsidy programme. In section 3, we outline the methodology and sources of data. Section 4 presents results on gender differences in the application of fertilizers within households. Finally, in section 5 we present concluding remarks.

2. Gender, Intra-household Decisions and Subsidies

The theoretical literature on household resource allocation revolves around two competing models of the household, namely unitary and collective models (Udry et al. 1995; Quisumbing and Maluccio 2000; Bourguignon et al. 2009). The traditional view has been the unitary model of the household, in which household decisions are analysed as if they are made by a unique decision making unit to maximize some common welfare index. On the other hand, there are collective models, in which household decisions emerge from bargaining among members of the household, resulting in Pareto efficient outcomes. These models allow different preferences among household members but decisions are made to achieve Pareto efficient outcomes. Most of these studies implicitly assume that the farming household behaves as if it were an individual farmer, hence ignoring plot level characteristics and the intra-household resource allocation of the household.

In the context of agricultural production in sub-Saharan Africa, Udry (1996) and Udry et al. (1995) recognize the complexity of household decision making in intra-household resource allocation and test the Pareto efficiency hypothesis using plot level information and characteristics. Pareto efficiency in the Browning and Chiappori (1994) tradition implies that factors of production will be allocated efficiently across plots and that there will be no differences in the productivity of different plots with the same crops controlled by different individuals in the household. The empirical results obtained by Udry (1996) and Udry et al. (1995) using plot characteristics, show that plots controlled by women produced more inefficiently than plots controlled by men

within the same household for the same crops. However, Akresh (2005) using a collective bargaining model, find that households in Burkina Faso that were experiencing negative rainfall shocks were less likely to exhibit Pareto inefficiency in intra-household resource allocation. Quisumbing and Maluccio (2000) find that assets controlled by women have a positive and significant effect on expenditure allocations toward the next generation, such as education and children's clothing. Grogan (2004) finds that households in Russia containing only female adults have significantly different resource allocation patterns than those containing adult males.

The FISP is targeted at households, with each targeted household expected to receive 2 coupons for subsidized fertilizers and one coupon for subsidized improved maize or/and legume seeds. In recent years the targeting guidelines have also encouraged communities to accord special consideration to vulnerable groups such as child-headed, female-headed or orphan-headed households and those households affected by HIV and AIDS (GOM 2008). However, in practice it has been found that although each household is expected to receive 2 fertilizer coupons, some households receive less or more than the expected number (Dorward et al. 2010).

The targeting at household level assumes that the household is a unitary decision making unit in the use of fertilizers. However, in many rural communities in Malawi, households tend to have multiple plots used for cultivation of different crops and controlled by different members of the household, and allocation of inputs may depend on the bargaining strength of household members. It is not clear whether such biases are also evident within the household with respect to allocation and use of fertilizers among plots controlled by different members of the households. Previous studies that have looked at access to subsidized fertilizers in Malawi find that female-headed households are less likely to receive coupons than male-headed households (Chirwa et al. 2011) and where female-headed households receive subsidy coupons they also tend to receive less compared to their male counterparts (SOAS et al. 2008; Dorward et al. 2010). In addition, male-headed recipient households tend to receive more maize fertilizer coupons than female-headed recipient households, with male-headed households receiving on average 1.55 coupons compared to 1.45 coupons received by female-headed households in 2008/09 (with 1.7 compared to 1.3 coupons received per households in 2006/07). With respect to communities' perceptions on who is likely to receive coupons, there were no significant differences between male-headed and female-headed households across regions (Dorward et al. 2010). In addition, in 2008/09 season 81 percent of male-headed households and 66 percent of female-headed households reported utilizing savings to obtain cash for coupon redemption, but a higher percentage of female-headed households relied on gifts (11 percent) compared with male-headed households (2 percent).

The findings on access to subsidized fertilizers from previous studies mask issues of who actually uses the fertilizers available to the household. Most of the coupons within the household were received by the household head. The data reveals that only 2.7 percent of households that received coupons in the 2008/09 had more than 1 member receiving coupons and 4.1 percent of households that received coupons had one person receiving more than two coupons. Given that most of the coupons were received by one member of the household and the possibility of pooling in households receiving more than one coupon, intra-household issues become important in determining the extent to which subsidized fertilizers reach and benefit female members of households.

3. Methodology and Data

In order to investigate gender issues in the use of coupons and utilization of subsidized inputs, we use both qualitative and quantitative approaches. In the quantitative approach, we investigate intra-household resource use through descriptive analysis and econometric analysis. The discussion of the quantitative analysis will be enriched or triangulated by qualitative data generated from focus group discussions in different communities. In the descriptive analysis, we review the differences in access to coupons by gender of household head, application of commercial and/or subsidized fertilizers and intensity of use of fertilizers by male and female household members.

Our econometric approach will be based on probit regression analysis in which we estimate the probability of applying fertilizers on a plot. We estimate the following model:

$$FP_{ij} = \alpha_0 + \alpha_1 FEM_{ij} + \Sigma_j \beta_j (FEM_{ij} \times \boldsymbol{X}_k) + \Sigma_k \gamma_k \boldsymbol{X}_k + \varepsilon_i \qquad (1)$$

where FP_{ij} is a dummy variable indicating whether fertilizer was applied on plot i controlled by member j in the household, FEM_{ij} is a dummy variable equal to 1 if member j controlling plot i is female, and X_k is a vector of household level characteristics and ε_i is the random error term. We estimate the model in equation (1) under three scenarios: (a) intra-household use assuming availability of fertilizers at the household regardless source of fertilizers, (b) intra-household use assuming availability of fertilizers in subsidized households, and (c) intra-household use assuming that only subsidized fertilizers were available to the household. We use gender of the household member who controls input and farming decisions on the plot as the main variable of interest and control for farmer characteristics and other household characteristics such as plot size, age of household head, headship of household, cultivation of tobacco, sale of maize, access to safely nets, previous access to subsidized fertilizers and district dummies. Our dependent variable is the likelihood of applying fertilizer on a plot and is defined as a dummy variable taking the value of 1 if the plot controlled by a household member had fertilizer applied in 2008/9 season, otherwise equal to zero. In the household questionnaire, for each plot households were asked to indicate whether fertilizer was applied on the plot or not.

The main independent variable of interest is the gender of the farmer. Doss and Morris (2001) notes that most conventional technology adoption studies define the gender of the farmer as gender of household head, but this masks the intra-household variations in adoption for female farmers in male-headed households[1]. Chirwa (2005) uses both the gender of the member who makes most farming decisions on the plot and the gender of household head in the study of adoption of hybrid maize seeds and fertilizers. In this study we use gender of the member who makes most farming decisions on the plot. The gender of who controls the plot is defined as a dummy variable equal to 1 if the plot is controlled by a female member of the household. If resource allocation (fertilizer application) is efficient, we expect to accept the null hypothesis that there are no differences in allocation of fertilizers to male and female controlled plots. In order to further investigate the impact of household characteristics on the gender of the farmer, we also include three interaction variables of household characteristics and the gender of the member who controls the plot: female-controlled plots and coupon recipient household, female-controlled plots and male-headed household and female controlled plots and household with commercial fertilizers.

Other variables in the model include plot size, male-headship of household, age of household head, household size, household land size holding, cultivation of tobacco, commercialisation of maize, household poverty self-assessment in 2007, use of commercial fertilizer in previous season (2007/08), access to subsidy in previous season, access to safety nets in previous season and district dummies. Plot size and household land holdings are measured in hectares. Male-headed household is represented by a dummy equal to one if the member controlling the plot comes from a male-headed household. Based on gender discrimination, we expect female-controlled plots in male-headed households to be disadvantaged with respect to application of fertilizers. Cultivation of tobacco and sale of maize capture the commercialisation agriculture for individual households and enter the models as dummy variables. We expect commercialisation to offer more incentives for application of fertilizers on different plots in order to maximize farm revenues. We capture the resource endowment of households by including the number of adult equivalents (family labour resource) and household's own assessment of poverty in 2007 to capture wealth. We hypothesise that households with available family labour and non-poor households are more likely to apply fertilizer on their plots. Availability of family labour facilitates better management of fertilized plots whose productivity largely depends on timely management such as weeding and application of fertilizers, both of which require labour among smallholder farmers.

Owing to the district-specific variability in access to fertilizers, we also include district dummy variables in the model. There are 14 districts in our sample, with Chitipa district as our base category. The districts include Chitipa, Karonga and Mzimba in the northern region; Kasungu, Nkhotakota, Lilongwe, Dedza and Ntcheu in the central region; and Mangochi, Zomba, Blantyre, Thyolo, Phalombe and Chikwawa in the southern region.

We utilize quantitative and qualitative data collected in the AISS 2009 covering 2008/09 agricultural season[2]. Household data come from a sample of 1,982 rural households drawn from 14 districts. Focus group discussions (FGDs) were conducted in 8 of the 14 districts covered by the household survey and in each district discussions were held with two groups (male and female)[3]. While the allocation and distribution of coupons is at household level, in order to investigate intra-household use of subsidized fertilizers, data on application of fertilizers is at plot level and each plot was identified with a household member who was mostly responsible for crop and input decision on the plot. The sample of households gives us 4,727 plot level observations. In focus group discussions, intra-household allocations were discussed within the context of overall resource allocation rather than relating to use of subsidized fertilizer in particular

4. Results and Discussion

4.1 Descriptive Analysis and Qualitative Evidence

Plot level analysis enables us to compare input use between female-controlled and male-controlled plots within the household. Out of 4,727 plots, 71 percent and 29 percent are male-controlled and female-controlled within the household, respectively. Table 1 presents the gender differences in member and household characteristics by gender of the member who makes input decisions on the plots, regardless of source of fertilizers. We find significant differences in the characteristics of the member and their household of origin across the variables, with the exception of sale of maize by the household. Male members of households are younger than female members, with an average difference of about 4 years. Almost all male members (99%) who control plots come from male-headed households while only 28 percent of female members who control plots come from male-headed households. This may suggest that females in male-headed households tend to have little control over farming decisions. Male members who control plots tend to originate from larger households and households with more land than female members who control plots. It is worth noting that in male-headed households only 10.4 percent of the plots are female-controlled (mainly spouses) while in female-headed households only 5 percent (3.1 percent being spouses) of the plots are male-controlled.

There are also significant differences in terms of households' participation in the cultivation of tobacco in the 2008/09 agricultural season. About 28 percent of male members controlling plots come from households that grew tobacco compared to only 15 percent of female members. The differences are statistically significant at

Table 1 Mean Member and Household Characteristics by Gender of Members Controlling Plots

Variable	All	Males controlling plots	Females controlling plots	Mean Difference
Age of Household Member	45.98	44.74	49.04	-4.305[a]
Male-headed Households (0/1)	0.782	0.985	0.281	0.703[a]
Household Size (adult equivalent)	4.956	5.122	4.545	0.577[a]
Household Land Size (hectares)	1.224	1.314	1.001	0.313[a]
Household grew Tobacco 08/09 (0/1)	0.239	0.275	0.150	0.125[a]
Household sold Maize 08/09 (0/1)	0.103	0.102	0.106	-0.004
Household access Social Safety Net 07/08 (0/1)	0.146	0.139	0.163	-0.024[b]

Note: (0/1) indicates dummy variable. Superscripts a, b and c indicate statistically significant differences at 1%, 5% and 10% levels.

the 1 percent level. However, there are no significant differences between households with male and female members controlling plots as regards households' sale of maize in the 2008/09 season[4]. Tobacco is the main cash crop grown by smallholder farmers in Malawi while maize is the main staple crop. The difference in the gender of control of crops within the households suggests that tobacco is mainly a men's crop while maize is gender neutral. Since tobacco is a cash income earning crop, due to gender biases in the control of cash incomes in Malawi society, men tend to control cash cropping activities within the household. There is, however, greater access to social safety nets among female members (16 percent) controlling plots than among male members (13 percent) controlling the plots and this difference is statistically significant at the 5 percent level.

Table 2 presents gender differences in plot size and access to and use of fertilizers among household members. Generally, plots controlled by men tend to be larger than those controlled by female members, with a difference of 0.06 hectares which is statistically significant at the 1 percent level. However, there are no statistically significant differences across male and female controlled plots as regards the frequency or intensity of overall fertiliser application. In terms of household access to subsidized fertilizers, the proportion of household members from households with access to subsidised fertilizers increased from 65 percent in 2007/08 to 75 percent in 2008/09. The lack of dominance of male members on use of subsidised fertilizers was also confirmed by focus group discussions in several districts. Most focus group discussions with females (such as in Zomba, Phalombe, Mzimba and Kasungu) revealed that decisions on the use of coupons and acquired fertilizers are collectively made by the family.

However, in some focus group discussions (such as in Chikwawa, Lilongwe and Karonga) it was reported that the use of coupons was mainly decided by men. In Ntcheu, the female group discussion argued that in a matrilineal system women should be in control of coupons. Women also argued in all the districts that if coupons were given to female members of the households, they were unlikely to sell the coupons. In most focus group discussions with men, it was noted that the families were involved in the decisions about use of coupons, although in a few districts, such as Zomba and Mzimba, men revealed that they were making most decisions about the use of coupons.

As regards access to commercial fertiliser, we also only find statistically significant differences between male and female members managing plots in 2008/09 at the 10 percent level but no differences in 2007/08 season. In contrast, there are significant differences in access to commercial fertilizers in both seasons between the gender of the controller of plots, with the proportion with access to commercial fertilizers in 2007/8 almost doubling among both male and female members of households. In focus group discussions, we also discussed how incomes generated from different sources were controlled within the household. Table 3 presents a summary of the views from male and female groups in various districts. There are a lot of variations in the decision making processes about control and use of incomes within the household. The dominant view, however, is that men, particularly husbands, tend to be

Table 2 Mean Differences in Farming Characteristics by Gender of Members Controlling Plots

Variable	All	Male controlled	Female controlled	Mean Difference
Plot size (Hectare)	0.382	0.399	0.340	0.059[a]
Application of Fertilizers (0/1)	0.653	0.649	0.662	-0.014
Fertilizer Intensity (Kg/Hectare)	107.0	107.5	105.8	1.677
Households Subsidized 08/09 (0/1)	0.750	0.757	0.732	0.025[c]
Households Subsidized 07/08 (0/1)	0.652	0.653	0.651	0.002
Household with commercial fertilizer 08/09 (0/1)	0.473	0.502	0.401	0.101[a]
Household with commercial fertilizer 07/08 (0/1)	0.342	0.376	0.258	0.118[a]

Note: (0/1) indicates dummy variable. Superscripts a, b and c indicate statistically significant differences at 1%, 5% and 10% levels.

Table 3 Reported Intra-Household Resource Allocation Decisions from FGDs

Source of Income	Decision Makers	Number of Male FGDs	Number of Female FGDs
Business income	Men	4	5
	Joint	2	1
	Individual	0	2
Incomes from produce sales	Men	4	6
	Joint	2	2
Incomes from public works programmes	Men	3	4
	Joint	2	2
	Individual	1	1
Income from *Ganyu*	Men	4	5
	Joint	2	3
Remittances	Men	3	3
	Women	0	1
	Joint	2	0
	Individual	1	4

Note: Two focus group discussions (1 male and 1 female) were conducted in each of the 8 survey districts.

the main decision makers within the household. Both male and female focus group discussions perceived that men mostly dominate in deciding the allocation of incomes from produce sales, across the income sources. There are also a few instances in which decisions about resources were said to be jointly made by the husband and wife. Another interesting observation made was that it is usually in poor households that household resource allocation is dominated by men: in 'not poor' households, discussions normally precede joint decisions about resource use.

There was a dominant view from focus group discussions with women that individual members tend to control their own resources from remittances and *ganyu* labour, but this was less prevalent among the focus group discussions with men. In many women's groups it was argued that the persons who receive the remittances are the ones who control this income and decide on its allocation, sometimes with consultations with family members. It was also observed that in many cases, it is women who receive remittances in the household, and they tend to control such income. Men's focus group discussions revealed that for *ganyu* and remittance incomes, although men were in control, in many cases the decisions on the use are made by the family. In some women's groups, income from business enterprises was typically controlled by owners of the business.

There was a general perception among women's groups that when men control resources, they tend to use it for selfish purposes such as beer, at the expense of the welfare of the household. This view was reinforced by comments from some of the focus group discussions with men. For instance:

> "Husband and wife sit down to discuss income allocation. Husband takes some to be spent on what he wants personally while the wife spends all of it on household needs." **[FGD with Men in Mzimba District]**

It appears that resource allocation within the household is embedded in the culture in which for households that are male-headed, the husband seems to have control over more resource allocations. However, the analysis shows that intra-household issues are complex and the extent to which males dominate over control and allocation of resources varies from one transaction to another and from one district to another. There are also cases in which sources of income are personalized and household members earning such incomes tend to have control over such resources, as well as increasing evidence of collective decisions within the households for particular types of incomes such as produce sales and incomes from safety nets.

4.2 Econometric Evidence

Table 4 presents descriptive statistics of the variables used in the regression models. The data show that a large proportion of plots were fertilized in 2008/09 agricultural season, accounting for about 65 percent of the plots. On about 29 percent of the plots women were the main decision makers in terms of input use and timing of crop activities on the plot. About 22 percent of female controlled plots belong to households that received subsidized fertilizer coupons but only 8 percent of female controlled plots belong to male-headed households and 12 percent belong to households that had acquired commercial fertilizers.

On average, the sizes of the plots were 0.38 hectares, and were as small as 0.1 hectare and as large as 2.4 hectares[5]. About 78 percent of the plots belong to male-headed households and the average age of household heads is 47 years. The average size of households in terms of adult equivalents is about 5 adult members. In terms of commercialisation of households about 22 percent of plots belong to households that cultivated tobacco in the 2008/09 season and only 10 percent belong to households that participated in the sale of maize that they cultivated in 2008/09. We also note that 33 percent of the plots belong to households that acquired commercial fertilizers in 2007/08 season households. Using a subjective self-assessment of poverty, the data show that most of the plots (86 percent) are owned by households that assessed themselves as poor. Access to other safety net programmes is not as common, but most of the households also acquired subsidized fertilizers in 2007/08, indicating high incidence of repeated access to subsidized fertilizers.

We now turn to our estimated regression models of correlates of the likelihood of application of fertilizer on plots held by household members. We use gender of the member who controls input and farming decisions on the plot as the variable describing decision making on fertiliser use, and control for farmer characteristics and other household characteristics. Thus, we examine the combined effects on plot fertiliser use of gender of the member, plot size, age of household head, headship of household, cultivation of tobacco, sale of maize, access to safely nets, access and previous access to subsidized fertilizers, and district dummies. Table 5 reports regression results for three models that were estimated: (1) intra-household use assuming availability of commercial and/or subsidised fertilizers at the household regardless of source of fertilizers – Model 1, (2) intra-household use assuming availability of commercial and/or subsidised fertilizers only in households receiving some subsidised fertiliser – Model 2, and (3) intra-household use assuming that only subsidized fertilizers were available to the household (i.e. excluding households who also obtained commercial fertilisers) – Model 3. The models include five gender variables: female-controlled plots, male-headed household, and interaction variables of female-controlled plots with coupon recipient household, male-headed household and household with commercial fertilizers. In all the three models, the F-statistics suggest rejection of the null hypothesis that all parameter estimates are equal to zero.

We find that significant gender differentials exist in the allocation of fertilizers to plots within the households, with female-controlled plots less likely to have fertilizer applications compared to male-controlled plots. This is only in the case where we pool the sample of subsidized and unsubsidized households in Model 1. The probability of applying fertilizer falls by 0.28 points for female-controlled plots, and the marginal effect is statistically significant at the 1 percent level. These results are similar to the findings in other studies in African agriculture such as Doss and Morris (2002) and Chirwa (2005), although in both those studies the coefficients of female were statistically insignificant. Model 1 results also show that female-controlled plots in coupon-recipient households were more likely to be fertilized as compared male-controlled plots and female-controlled plots in female-headed households. Access to subsidized fertilizers improves the odds for female-controlled plots, with the probability of fertilizer application increasing by 35 percent compared to female-controlled plots in male-headed and non-coupon recipient households. This implies that for a female household member in a coupon recipient household the mean increase in the probability of applying fertilizer on the plot is 0.07 points compared to a decrease of 0.28 points for a female member in a household without subsidized fertilizers.

Female-controlled plots in male-headed households were less likely to be fertilized than male-controlled plots as well as female-controlled plots in female-headed households, confirming the earlier observations in focus

Table 4 Descriptive Statistics of Model Variables

Variable	Mean	Std Dev	Min	Max
Application of fertilizer on the plot (0/1)*	0.6526	0.476	0.000	1.000
Female household member (0/1)*	0.2932	0.455	0.000	1.000
Female member in coupon recipient household (0/1)*	0.2192	0.414	0.000	1.000
Female member in male-headed household (0/1)*	0.0829	0.276	0.000	1.000
Female in household with commercial fertilizer (0/1)*	0.1168	0.321	0.000	1.000
Plot size in hectares	0.3832	0.291	0.100	2.400
Male-headed households (0/1)*	0.7798	0.414	0.000	1.000
Age of household head	47.138	15.45	19.000	95.000
Number of adult equivalents	4.9455	2.113	1.000	16.980
Log of household land size in hectares	0.0005	0.635	-2.291	1.929
Household that grew tobacco (0/1)	0.2293	0.420	0.000	1.000
Household that sold maize (0/1)*	0.1015	0.302	0.000	1.000
Household had commercial fertilizers in 2007 (0/1)*	0.3345	0.472	0.000	1.000
Household own assessment as poor in 2007 (0/1)*	0.8570	0.350	0.000	1.000
Household had access to safety nets 2007 (0/1)*	0.1441	0.351	0.000	1.000
Household had access to subsidized fertilizers 2007 (0/1)*	0.6522	0.476	0.000	1.000

Note: * (0/1) indicates dummy variable.

Table 5 Marginal Effects from Probit Estimates of Intra-Household Fertilizer Use

Dependent Variable: Plot controlled by member in household was fertilized (0/1)	Model 1 All Households		Model 2 (subsidy and/ or commercial)		Model 3 (subsidy only)	
	dF/dx	*t-ratio*	*dF/dx*	*t-ratio*	*dF/dx*	*t-ratio*
Female household member *	-0.2844	-3.50[a]	0.0780	1.30	0.0401	0.42
Female member in coupon recipient household *	0.3502	13.09[a]	-	-	-	-
Female member in male-headed household *	-0.2848	-3.32[a]	-0.1581	-2.03[b]	-0.0730	-0.65
Female in household with commercial fertilizer *	0.2154	7.30[a]	0.0729	2.66[a]	-	-
Plot size in hectares	0.4308	12.59[a]	0.4664	11.99[a]	0.4502	8.42[a]
Male-headed households *	0.1223	1.65[c]	0.0535	0.84	0.0120	0.12
Age of household head	-0.0008	-1.45	-0.0003	-0.64	0.0000	-0.07
Number of adult equivalents	-0.0043	-1.12	-0.0085	-2.37[b]	-0.0086	-1.66c
Log of household land size in hectares	-0.2389	-15.05[a]	-0.1672	-13.34[a]	-0.2527	-11.52[a]
Household that grew tobacco *	0.1368	6.88[a]	0.1067	6.19[a]	0.0755	2.51b
Household that sold maize *	0.1255	4.90[a]	0.0817	3.59[a]	0.0937	2.82[a]
Household had commercial fertilizers in 2007 *	0.1510	8.59[a]	0.0776	4.58[a]	0.0101	0.31
Household own assessment as poor in 2007 *	-0.0630	-2.99[a]	-0.0447	-2.29[b]	0.0069	0.22
Household had access to safety nets 2007 *	0.0109	0.49	0.0017	0.08	0.0276	0.96
Household had access to subsidized fertilizers 2007 *	0.1698	9.44[a]	0.0570	3.05[a]	0.0389	1.43
District fixed effects?	Yes		Yes		Yes	
Number of observations	4727		3551.0		1944	
Wald chi2(25)	1071.1		593.7		392.0	
Prob > chi2	0.000		0.000		0.000	
Pseudo R-squared	0.2281		0.1826		0.2003	

Notes: (*) dF/dx is for discrete change of dummy variable from 0 to 1. Superscripts a, b and c denote statistically significant at 1%, 5% and 10% level, respectively.

group discussions that typically in male-headed households, resources are likely to be controlled by husbands. However, this is only the case when commercial fertilizers are also available to the household (models 1 and 2) but it is not the case when households have access to subsidized fertilizers only. The results show that being a female member controlling a plot in a male-headed household reduces the probability of applying fertilizers by 28 percent in the model of subsidized and unsubsidized households (Model 1), but this bias reduces to 15 percent in subsidized households (Model 2). Hence, the bias against female-controlled plots in male-headed households is reduced as compared with the case when commercial fertilizer is also available at the household level. In Model 1, the results imply that the mean decrease in the probability of a female-controlled plot being fertilized in a coupon-recipient and male-headed household is 0.21 points. In Model 2, the decrease in the mean probability of applying fertilizer on female-controlled plots in male-headed households is only 0.08 compared to a decrease of 0.57 points for the same situation in Model 1.

In Models 1 and 2, we find that access to commercial fertilizers in 2008/09 season also favours women-controlled plots in the application of fertilizers and raises the probability of application of fertilizers on the plot by 21 percent in model 1 compared to male-controlled plots as well as female-controlled plots in households without commercial fertilizers. This is lower than the increase in the probability of 35 percent with households that received subsidised fertiliser. Among subsidized households (Model 2), the coefficient of female member in households with commercial fertilizer is statistically significant at the 1 percent level. The results show that the availability of commercial fertilizer in the household favours female-controlled plots, and increases the probability of fertilizer application by 7 percent. Overall, comparing Models 1 and 2, the mean decrease in the probabilities of applying fertilizers on a female-controlled plot in a male-headed household and a household with commercial fertilizers are 0.35 points and 0.007 points, respectively. This suggests that the bias against female farmers within households increases when only commercial fertilizers are available to the household. One likely explanation for low bias or lack of bias in fertilizer allocation in subsidized households is that most of the subsidy fertilizer is used for production of maize, which is mainly produced to meet subsistence needs for most households; and women tend to have higher bargaining strength over the provision of food in the household.

Male headship of households is positively related to the probability of applying fertilizer on the plot, but the coefficient is only statistically significant at the 10 percent level in Model 1. Male headship raises the probability of applying fertilizer on a plot by 0.12 points. The fact that male headship is only significant only in the model that includes households that were not subsidized confirms the lack of gender bias when households have access to subsidized fertilizers.

The results also suggest that larger plots are more likely to be fertilized than smaller plots, and the marginal effect is statistically significant at the 1 percent level in all three models. However, plots that belong to households with larger land holding tend to be less fertilized. The coefficients of the household land holding size is negative and statistically significant at the 1 percent level in all three models. This may be due to the fact that most rural households are too cash constrained to afford fertilizers and tend to be very selective on plots that they apply fertilizers.

Commercialisation of agricultural activities using indicators such as cultivation of tobacco and sale of maize and acquisition of commercial fertilizer in the previous season by households is positively related to the probability of applying fertilizers on the plots. The coefficient of cultivation of tobacco is positive and statistically significant at the 1 percent level in Models 1 and 2 and at the 5 percent level in Model 3. Tobacco cultivation improves the probability of fertilizer application on the plot by 8–14 percent. Similarly, the coefficient sale of maize is statistically significant at the 1 percent level in all three models and the coefficients suggest that maize sales raise the probability of plot being fertilized by 9–13 percent. The results suggest that commercialisation enables households to invest in fertilizers across the plots.

Self-reported poverty in the 2007/08 season may be one of the constraints to the 2008/09 application of fertilizers by households, with plots that belong to poor households less likely to be fertilized regardless of availability of commercial or subsidized fertilizers. The marginal effects of self-reported poverty are negative and statistically significant at the 1 percent level in Model 1 and 5 percent level in Model 2, and shows that the probability of applying fertilizer on plots falls by 6 percent and 4 percent among plots that belong to poor households, respectively. However, in households with only subsidized fertilizers being poor does not matter.

Households' access to subsidized fertilizers in the previous season increases the probability of the plot being fertilized, demonstrating the positive cumulative effects of fertilizer adoption or continued access to subsidized fertilizers. However, this relationship is only statistically significant at the 1 percent level in models where commercial fertilizers are also available among households but not significant among purely subsidized households. The probability of applying fertilizer to a plot with access to subsidy in previous season increases by 0.17 points and 0.06 points in Models 1 and 2, respectively.

Conclusion

This paper has demonstrated that in a socio-cultural environment in which men tend to dominate the decision making process within the household over allocation of income and resources, intra-household issues in the use of subsidized fertilizers are important in understanding the effectiveness of input subsidies and how they create more equal opportunities for female and male members of the household. Generally, men tend to control incomes from different sources even when such incomes are earned by female members, but there are a lot of exceptions and variations depending on the source of income and the poverty status of households. Using male and female control of plots, the study tests the efficient resource allocation hypothesis for the use of fertilizers among male and female controlled plots within the household.

Important differences exist in the characteristics of farmers and control of resources within households between male and female farmers. Male farmers tend to originate from households whose heads are younger, male and have larger household size compared to female farmers. Female farmers on average belong to households with smaller land parcels, households that grew less tobacco and households with higher access to social safety nets than their male counterparts. However, cultivation of maize tends to be gender neutral, with no significant differences between male and female farmers. Female farmers have on average smaller plots than male farmers and female farmers belong to households with less access to commercial fertilizers. These differences suggest that female farmers are disadvantaged in many respects in terms of access to resources, which may adversely affect their farming activities.

There are also diverse views on the allocation of different types of incomes within the households. The dominant view from both male and female groups is that men tend to control the allocation of incomes from business enterprises, crop sales, public works programmes and casual labour (*ganyu*) and remittances (particularly from men's focus group discussions) while individual members earning such incomes dominate with respect to remittances (particularly among female focus group discussions). The dominant position in the decision making of incomes within households in Malawian society has implications on the allocation of social transfers or subsidies at household level.

The study finds that there are gender differences in the incidence of application of fertilizers, to the disadvantage of female-controlled plots when households have access to fertilizers regardless of source of fertilizers. This occurs first because female-headed households are less likely to use fertiliser than male-headed households, and second because female-controlled plots are less likely to use fertiliser than male-controlled plots in male-headed households. However, such gender differentials are less evident among subsidized households, except when subsidized households also have access to commercial fertilizers. Female-controlled plots in male-headed households are also less likely to benefit from available fertilizer among subsidized households. If we only consider the sub-sample of purely subsidized households, there is no difference in the application of fertilizers by gender of farmer who controls the plot. This implies that there is efficient allocation of subsidized fertilizers in such households. The bias in application of fertilizers arises when we pool

purely subsidized households, partially subsidized and non-subsidized households. Nonetheless, the availability of commercial fertilizers at the household level also increases the chances of applying fertilizer on female-controlled plots, although female-controlled plots in the pooled sample remain disadvantaged.

Although female-headed households are less likely to receive coupons, potentially joint decision making prevails when it comes to use of subsidized fertilizers within the household, hence reducing the bias against female-controlled plots. This may be due to the fact that most of the subsidized fertilizer is meant for the cultivation of maize for subsistence needs, in which case women may have stronger countervailing power as providers of basic food needs at the household level. It is therefore important that analysis of gender issues in the subsidy programme goes beyond examination of differential access of subsidized fertilizers among male-headed and female-headed households, and also includes examination of intra-household use of subsidized fertilizers. The study implies that social transfers that focus on provision of basic services, such as input subsidy for household food security, are likely to be efficiently used even if they are targeted at household level instead of at individual household members.

End Notes

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1 Doss (2002) in a study of cropping patterns in Ghana uses three definitions of the gender of farmers: (a) the gender of the individual who holds land in the household, (b) the gender of the household head, and (c) gender of the member in the household who controls revenues from farming activities on the plot.

2 See Dorward (2010) for a description of data and the coverage of the household survey and focus group discussions.

3 Focus Group Discussions were conducted in the following districts: Karonga and Mzimba in the northern region; Kasungu, Lilongwe, and Ntcheu in the central region; and Zomba, Phalombe and Chikwawa in the southern region.

4 The sale of maize does not account for the fact that some of these households also are net maize buyers. In this case, the sale of maize is used here as one of the indicators of commercialisation of agriculture.

5 This is the case because we eliminated outlier plot sizes that were less than 0.1 hectare and those that were more than 2.5 hectares.

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