

Good and Efficient? Women's Voice in Agriculture

Ralitza Dimova

Institute of Development Policy and Management, University of Manchester and IZA, Bonn
Ralitza.Dimova@manchester.ac.uk

Ira N. Gang

Department of Economics, Rutgers University and IZA, Bonn and CReAM, London
gang@economics.rutgers.edu

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ABSTRACT

The potential of engaging female agricultural producers in high value crop activities has been in the increasing focus of much of the recent development literature and policy discourse. Using a rich representative household survey for Malawi, this work draws a profile of successful women farmers and the policies and interventions associated with this profile. Our study finds that female cash crop decision-making has significant impact on both efficiency and welfare. Female cash crop decision-making is encouraged by female ownership of land, credit allocations to women, and village-level infrastructure (development agencies, savings and credit unions).

La capacité des productrices agricoles de s'engager dans des activités agricoles fortement rémunératrices a été d'un intérêt croissant en grande partie dans la littérature récente du développement. A partir d'une enquête riche et représentative auprès des ménages du Malawi, ce travail dresse le profil des agricultrices réussies et les politiques et les interventions associées à ce profil. Notre étude montre que la prise de décision féminine de la culture de rente a un effet significatif sur l'efficacité et le bien-être. La prise de décision féminine de la culture de rente est incitée par la possession de terre par les femmes, des allocations de crédit aux femmes, et l'infrastructure villageoise (agences de développement, d'épargne, et de coopératives de crédit).

Keywords: microanalysis of farm households, empowering women, cash crops, stochastic frontier analysis, farm production efficiency, policy interventions

JEL classification: Q12, O2, O13, J16

Correspondence: Ralitza Dimova, Institute of Development Policy and Management, School of Environment and Development, The University of Manchester, PO Box 88, Manchester, M60 1QD, UK Ralitza.Dimova@manchester.ac.uk; Ira N. Gang, Department of Economics, 75 Hamilton Street, Rutgers University, New Brunswick NJ 08901-1248 USA gang@economics.rutgers.edu

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1. Introduction

Few areas of research and policy debate in social sciences have achieved as much consensus as those of the role played by women in assuring food productivity and security and the role of empowered women in enhancing the next generation's human capital. Women's productivity in their respective activities is found to be at least on par with that of men (Peterman et al, 2011). Yet, throughout Sub-Saharan Africa, lucrative cash crops are typically perceived as "male crops" while crops for home consumption are perceived as "female crops" (Kasante et al, 2001; World Bank and Malawi, 2007; Duflo and Udry, 2004). Since income from "male crops" tends to be put into different uses than income from "female crops", often with deleterious consequences for overall household welfare enhancement (e.g., Haddad and Hodinott, 1994; Duflo and Udry, 2004), recent discussion has focused on the potential of engaging female agricultural producers in high value crop activities. In fact, female empowerment is one of the leitmotifs of the increasingly prolific literature on high value agriculture (Dolan and Serby, 2003).

The consensus on the positive link between female empowerment and household welfare has stimulated research on the entry barriers women face getting into high productivity (e.g. cash crop) agricultural activities. The general finding is that women tend to be severely disadvantaged in their access to inputs in the production process and technology. For example, in 80% of the studies surveyed by Peterman et al (2011) men were found to have higher mean access to fertilizers than women. In 53% of the studies surveyed by the same authors, men were found to have higher mean access to extension services, while in 67% of the studies, men were found to reap greater political and social capital benefits than women. This evidence highlights a potential

need for government or institutional/social intervention to enhance the possible gains from female agricultural empowerment.

While the existence of greater entry barriers to high value activities for women is well documented, significantly less attention has been devoted to the barrier removing consequences of government and non-government/social interventions. As an example of such interventions, recent theoretical models on high value agriculture suggest that interlinking transactions in contract farming, for example in the context of agricultural cooperatives, is likely to reduce entry barriers into high productivity cash crop activities for small farmers (Gangopadhyay, 2006). We therefore find it imperative to explore the productivity enhancing and female empowering potential of institutional forms, alongside alternative government interventions.

Using stochastic frontier analysis-- a popular technique for assessing agricultural productivity -- we explore the efficiency enhancing impact of government and institutional/social interventions in the context of removing the barriers blocking women's entrance into high value agriculture. As is common in frontier analysis, we use variables, such as those capturing cooperative village arrangements and proxies of government policies, to explain the (in)efficiency parameter of the production function estimate (e.g. Seyoum et al, 1998). We assess the effects of these interventions, as well as female decision-making in cash crop production and institutional factors, such as land ownership, on productive efficiency in agriculture and compare the results for male and female headed households.

We follow the efficiency analysis with a Heckman-type treatment model (Dimova and Wolff, 2008), accounting for the non-random selection of individuals into an activity, in order to test the null hypothesis that the entry of women into cash crop activities is more welfare

enhancing than reliance on subsistence (food crop) agriculture. We try to get a handle on which women undertake high-value agriculture, what their characteristics are, and which policies/interventions are associated with this involvement.

The context of our analysis is Malawi, one of the poorest, predominantly agricultural, countries in the world, which shares key characteristics with poor tropical African economies, namely comparative advantage in cash crop activities (most importantly tobacco, but also more traditional commercial crop activities such as groundnuts, cotton and hybrid maize), together with a threat to food security, especially in an environment of rising food prices. While subsistence constraints have been shown to push households into low risk and low return activities and hence down the spiral of increasing welfare deterioration (Whiteside, 1999), lucrative agricultural choices have been characterized by significant entry constraints facing smallholders (Harashima, 2008). Entry barriers to high productivity activities are found to be highest for women (Whiteside, 1999).

We base our analysis on the Third Integrated Household Survey of Malawi (2010/2011). This is a rich, representative household survey, which contains not only the typical Living Standards Measurement Surveys' (LSMS) demographic, labor market, consumption and income information, but also valuable information on agriculture. We have not only high quality data on the value of cash and food crops produced and who is the main decision maker in their production, but also on key inputs to the production function, as well as information on various extension activities and interventions, agricultural credit, inputs to which a farming household has access, and access to various co-operative and contractual arrangements.

In the next section we provide a brief background on agricultural decision-making and various interventions in Malawi over the last decade. Section 3 discusses our data and issues with the data. The methodology we follow is outlined in Section 4. In Section 5 we discuss the results of our empirical analysis. Section 6 concludes.

2. Background: Gender, Agricultural Decision-making and Interventions in Malawi

Malawi became independent in 1964. A landlocked country, approximately 40% of its GDP is derived from agriculture, with 80% of foreign exchange earnings derived from cash crops such as tobacco and groundnuts and 80% of its workforce employed in agricultural activities. In the 1970s-1990s Malawi followed typical sub-Saharan policies of heavy government involvement and stimulation of cash crops (predominantly tobacco) at the expense of food crops, with a dramatic reversal of policy in the 1990s.

During the first three decades of independence, all key agricultural decisions, such as extension, technological development and marketing of agricultural production, were taken by the Agricultural Development and Marketing Corporation (ADMARC), which sold inputs to and bought produce from farmers. The corporation subdivided agriculture into two subsectors, a smallholder sector made up of predominately subsistence oriented producers, and a cash crop sector with production concentrated in estates. These two subsectors contribute respectively to 70% and 30% of agricultural GDP. The prices of the key staple foods were kept artificially low, while all sectoral revenues were channeled into the development of the cash crop estate sector, viewed as the engine of growth.

As in other similar sub-Saharan economies, the dramatic change in terms of trade during the 1970s (together with other external shocks such as the war in Mozambique and a severe drought in 1979-80) highlighted the failure of the government led, agricultural export based policies. Series of food crises paved the way to IMF and World Bank led adjustment programs, including, among others, active encouragement of smallholder involvement in the production of exportable cash crops such as tobacco, groundnuts and cotton and adoption of higher value hybrid maize varieties. Together with a discontinuation of maize fertilizer subsidies, these policies contributed to a significant reallocation out of food crops and into cash crops among smallholders (Harrigan, 2001). But severe drought in 1992-1994 and a renewed food crisis contributed to a further re-thinking of input based government strategies, the most widely discussed being the seed and fertilizer subsidies to Malawian smallholder farmers (e.g. Dorwand and Kydd, 2004).

Perhaps more academic and policy oriented literature on Malawi has emerged assessing the food and seed subsidy programs of the late 1990s and early 2000s than any other aspect of the economy. The Farm Input Subsidy Program (FISP), which developed out of predecessors such as the Starter Pack Scheme of 1998, was administered through a series of coupon vouchers enabling households to purchase fertilizer, hybrid seeds and pesticides at reduced prices (Dorwand and Chirwa, 2009). The four criteria to identify beneficiaries were that (i) households should own land, which is cultivated in the relevant season, (ii) the household should be a bona fide resident of the village, (iii) only one beneficiary should be eligible in a household, (iv) vulnerable groups, especially households headed by women and children, should be given priority.

Despite the good intentions of the program, evaluation studies reach contradictory conclusions. Although a few authors, such as Nyairongo (2005) emphasize the positive outcomes of the programs in a context where markets for seeds and fertilizers were virtually non-existent, most of the literature focuses on their inequality enhancing effect as non-poor and unintended households ended up being included, while poor and intended households were excluded from the benefits (Coady et al, 2002). The main shortcoming of the program was the large number of eligible households compared to the number of coupons allocated to villages, which led to informal re-distribution systems in favor of relatively better off and male headed households (Holden and Lunduka, 2010; Dorwards et al, 2010).

While significantly less literature has focused on key agricultural outcomes of non-fertilizer and seed oriented policies, such as the choice among food and cash crops and its effect on household welfare, the few more general studies tend to support the arguments of the above literature. While there is a general consensus on the fact that involvement in high value crops such as tobacco, groundnuts and hybrid maize (and to a significantly lower extent, cotton), have a sizeable positive impact on crop income and household welfare, relatively better off (and/or male dominated) households are more likely to receive credit and benefit from extension services (World Bank, 2006).

The gender specific literature on agriculture in Malawi appears to be in-agreement that although females are disproportionate contributors to agricultural development, supplying over 70% of agricultural labor, they have not truly benefitted in the process. In an extensive overview of female empowerment in Malawi, Nkonjera (2011) identifies land ownership patterns, access to inputs, extension services and credit as the four most important barriers to female empowerment in Malawi's agriculture. While access and control of land has in general

been identified as one of the most important setbacks for women farmers (Allendorf, 2007), the subdivision of Malawian land ownership into patrilineal and matrilineal systems, with the matrilineal system covering approximately 2/3 of the country's population, at least on paper appears to diminish the role of female exclusion from productivity enhancing agricultural activities, compared to environments where all land is *de facto* owned by males. Under the matrilineal system in Malawi, land ownership is passed from mother to daughter, though sons can acquire land rights through marriage. However, the matrilineal dominance in Malawi's land ownership is not without caveats. Authority over the land is still vested in men, e.g. the brother or the uncle of the female inheriting the land. Furthermore, husbands are reluctant to develop or invest in their matrilineal land due to limited authority over it and a fear of future expropriation (White, 2007).

As discussed above, caveats exist also in the allocation of inputs such as fertilizers and seeds to vulnerable households as those headed by women. While several authors have identified seed multiplication programs targeting female farmers as fairly successful, (Wiggins and Cromwel, 1995), others have argued that their impact has been slow as the inputs have either been sold or consumed by the poor household to address their immediate food needs. There has been a similar challenge to the provision of extension services to female farmers, mostly related to the scheduling of such activities in a way consistent with female reproductive roles (Kabira, 1997). While the approach by the government of Malawi has changed from top down and male dominated to demand driven and gender responsive (GoM, 2000), Quisumbing and Pandolfelli (2010) do not find a significant impact, especially in so far as female integration is concerned. Similar barriers of access to credit have been identified in both Malawi and beyond (Quisumbing and Pandolfelli, 2009).

While research on the subsidy and seed coupon schemes and the land ownership institutional framework in Malawi is truly prolific, evidence on community development projects and agricultural cooperatives is almost nonexistent. Community-based institutions, such as savings and credit unions and agricultural cooperatives, have long been in existence, but the use of these and other institutional forms as a tool of government interventions and development strategies is relatively new. Although lending groups and credit cooperatives have the potential to successfully provide credit to small-scale farmers by reducing transaction costs and lowering the risk of default, while agricultural cooperatives can enable farmers to join together to acquire inputs and market production, enhancing productive capacity and gaining access to markets, the success record on either of these institutional arrangements in the broad development literature is mixed. Indeed, while community-based and community-driven development are among the fastest growing mechanisms for channeling development assistance, with the World Bank portfolio alone amounting to \$7 billion, recent comprehensive reviews of evidence suggest that projects relying on community participation may not been as effective in targeting the poor as originally envisaged (Mansuri and Rao, 2004).

The scarce evidence on the performance of community and village level productivity and welfare enhancing projects conforms to the general trends. While the performance of groups and credit cooperatives in rural lending in Malawi has often been described as exemplary in achieving high repayment rates at par with those in Bangladesh (Happi and Feder, 1990), much less is known about the efficiency and welfare enhancing effects of actual loan use. The evidence on the performance of agricultural co-operatives is typically described as less impressive. Nkhoma and Conforte (2011) describe in detail the market access, governance, managerial and start up incentive problems of agricultural cooperatives in Malawi, which put in question their

very sustainability as organizations. Finally, although after decentralization in 1994, village and area development committees are seen as holding the greatest potential for initiating successful broader village development projects and mobilizing labor for their implementation, their success is conditional on the successful resolution of a wide range of political, socio-economic, administrative and financial problems at the local level (Hussen, 2010). To the best of our knowledge, there is no evidence on the gender implications of community development projects and agricultural cooperatives in Malawi.

Given the identified importance of land ownership, coupons for fertilizers and seeds, credit and extension services, broader community development institutions such as village development committees and narrower community development institutions such as agricultural cooperatives and savings and credit unions on village development in general and on the productivity and the access of females in Malawi to high value activities in particular, in our analysis we place special importance on these.

3. Data and Issues

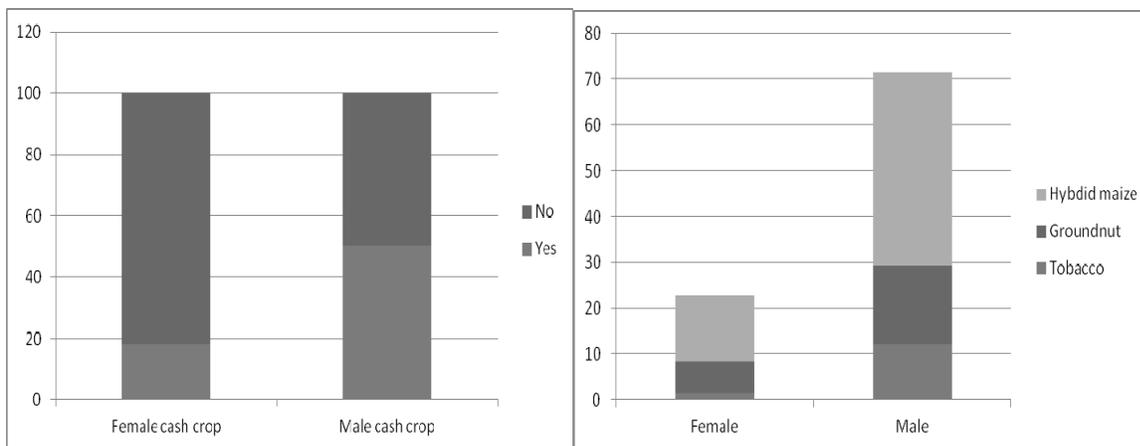
Our empirical analysis uses the Third Integrated Household Survey (IHS3) of Malawi, conducted between March 2010 and March 2011. This is a representative survey for the whole territory of the country, conducted by the National Statistical Office of Malawi, which received technical assistance from the World Bank as part of the World Bank's Living Standards Measurement Study (LSMS). After accounting for missing observations and other data inconsistencies, we are left with a total household sample of 10401 observations. We restrict the sample to those households who had access to land and derived income from agricultural production in the reference period, which leaves us with a sample of 10085 observations.

The survey is incredibly rich. Aside from the usual LSMS household and individual level questions aimed at assessing expenditure, household income, labor force characteristics, education and social assistance, the survey contains a separate section on agriculture. It is not only possible to identify what the different crops produced and the inputs into and outputs from the production process, but it is also possible to identify who in the household is responsible for which activity and who is responsible for the allocation of earnings derived from each activity. Of particular importance to our analysis, the survey contains useful information on various interventions (described below and in Table 1), often allowing us to identify the person in the household towards whom the intervention is directed. While there is certainly not a one-to-one correspondence between the survey responses and the policy interventions discussed in the preceding section, the intervention programs do seem to naturally link to the nature of the interventions perceived by respondents. We are also able to identify who owns the land used in agricultural production.

In Table 1 we identify and describe the variables – including whether the cropped land is female owned and who in the household is responsible for making agricultural production decisions – that serve us by capturing various types of interventions. Interventions that strike at the household and people within the household level include fertilizer and seed subsidy policies which have been paramount in the agricultural policy history of Malawi. In fact, the data identifies whether the household (and in fact which member of each household) receives any fertilizer or seed coupons, loans, extension services and various social benefits. Village infrastructure highlights community level cooperative behavior we explore the role of village development institutions, savings and credit unions in the village, farm clubs, women’s groups and agricultural cooperatives.

We introduce the key role gender plays by looking at bar charts of the proportion of men and women involved in commercial/cash crop activities such as tobacco, groundnuts and hybrid maize (and to a lesser extent cotton). These are typically identified as the key high value, welfare enhancing agricultural activities. In Figure 1 we compare them with those of men and women involved in food crop activities. We see that while 50.13% of male farmers are involved in at least one type of high value activity, this is true for only 18.25 % of the female farmers. Furthermore, females appear to be particularly excluded from high value export activities such as tobacco, which involves only 1.48% of the female farmer sample, but 12.04% of the male farmer sample; the corresponding values for groundnuts are 7.09% for females and 17.43% for males. Even in the adoption of high value maize varieties, such as hybrid maize, male farmers are dominant, accounting for 41.94% of the sample, compared to 14.26% of the female sample.

Figure 1: Male and female involvement in cash crop activities



One of the questions we are interested in answering concerns the characteristics of female commercial/cash crop producing farmers. As a first step, Table 2 highlights some of the

household and policy characteristics of women involved in cash crop production compared to women that are not involved in cash crop production. We explore these determinants of female involvement in cash crop production with greater rigor in the second part of our empirical analysis in Sections 4 and 5. We see that female cash crop decision makers tend to come from female headed families and are less likely to be involved in either monogamous or polygamous marriages. The burden of young children (of ages less than 5) appears to affect negatively the propensity of women to be involved in cash crop production. However, more women are involved in cash crop production who live in households with older children (ages five to 15) and elderly females of ages 65 and over, possibly on account to the possibility of employing these family members in agricultural production. Interestingly, education does not appear to have a strong influence on the decision of females to be actively involved in cash crop production.

The means of all policy variables in the female cash crop sample exceed those in the non-cash crop female sample, indicating that coupon-based policies and extension policies, as well as stylized social security methods may have a positive effect on the decision of females to become cash crop producers. The same is true for all village infrastructure variables: village development agencies, savings and credit unions, farmers and women's groups and agricultural cooperatives. Finally, Table 2 shows that female land ownership in the cash crop sample greatly exceeds female land ownership in the non-cash crop sample, indicating that despite the complex issues related to *de facto* control over land resources discussed earlier, *de jure* ownership of land by women may indeed play an important role in female agricultural empowerment. In our empirical analysis below, we explore with much greater rigor the impact of key household and policy characteristics on the decision of female to be involved in important high value agricultural decisions and the impact of these decisions on farm level efficiency and household welfare.

4. Methodology

4.1. Modeling farm efficiency: theoretical note and empirical specification

Our objective here is to find out whether female decision-making enhances farm level efficiency in the production process and identify household level and village level characteristics that contribute to efficiency enhancement.

Standard production theory assumes implicitly that all production activities take place on the frontier of a feasible production set (subject to random errors) that is technically attainable for the given inputs. This assumption is relaxed in the production efficiency literature which considers the possibility that technical inefficiency might result in production activities taking place inside the frontier. The stochastic frontier approach estimates the underlying production technology along with technical inefficiency for individual producers (Kumbhakar and Lovell, 2000). The unique feature of the stochastic frontier model is that the error term is the sum of a one-sided (i.e., non-negative) technical inefficiency term and a two-sided noise term.

We can write the production relationship as:

$$y = X\beta + (v - u) \quad [1]$$

where X is a vector of factor inputs and v and u are distinct error components, v is the *iid* error term which follows a normal distribution with a zero mean and positive variance, and u is the non-negative inefficiency term that has a half normal distribution (Kumbhakar and Lovell, 2000). Stochastic frontier analysis allows for deviations from the frontier – for the actual output of the farm to be inside the (unobserved) frontier. These deviations can be decomposed using

regression analysis allowing us to examine the impact of policies and other factors on the distances farms are from the frontier.

Inefficiency (at the farm-level) can be modeled as:

$$u = Z\delta \quad [2]$$

where Z is a vector of explanatory variables which can contribute to the farm not having achieved maximum efficiency (Battese and Coelli, 1995). The two equations are estimated simultaneously using the maximum likelihood method, and the resulting estimates are unbiased and efficient. With the stochastic frontier approach, the estimated (non-negative) values of u can tell us not only how efficient a farm is, but also with it we can directly estimate the impact of farm characteristics (Z). If a Z variable lowers u (i.e., increases technical efficiency), the marginal effect will tell us by what percent output will increase if a Z variable is increased by one percent.

In this paper, we adopt the Battese and Coelli (1995) approach to modeling output and efficiency. In keeping with the frontier literature on agriculture, we model output using a translog production function as a function of land, labor and capital, namely:

$$\begin{aligned} \ln y = & \beta_0 + \beta_1 \ln m + \beta_2 \ln l + \beta_3 \ln k + 1/2[\beta_4 \ln m^2 + \beta_5 \ln l^2 + \beta_6 \ln k^2] \\ & + \beta_7 (\ln m \times \ln l) + \beta_8 (\ln m \times \ln k) + \beta_9 (\ln l \times \ln k) + v - u \end{aligned} \quad [3]$$

where y is the total value of agricultural output, m is the total land size used for agricultural production in hectares, l is the total monthly hours of family and hired labor used, k is the total value of capital used, u is the half-normally distributed inefficiency term and v is the *iid* error term.

Next, we model u in equation [3] as a function of relevant for Malawi policy variables and other factors which explain inefficiency, namely

$$u = \delta_0 + \delta_1 \text{RoleWomenInDecisionMaking} + \delta_2 \text{GenderOfLandOwner} + \delta_3 \text{GovernmentInterventions} + \delta_4 \text{VillagePolicyInfrastructure} + \delta_5 \text{OtherFactors} + e \quad [4]$$

As women are *de facto* involved in food crop production, we are mainly interested in finding out whether female decision-making in cash crop production plays a significant role in reducing farm level inefficiency. With the paramount importance of policies related to fertilizer and seed subsidies in the agricultural policy history of Malawi, we also explore the role of receipt of either coupon or seed fertilizer¹ on farm level efficiency. Similarly, we investigate the effect of farm level extension services. In so far as village level policy infrastructure is concerned, we explore the role of village development institutions, savings and credit unions in the village, farm clubs, female clubs and agricultural cooperatives. Given the ambiguities in the literature related to any of these policy variables, we do not have clear priors related to their estimates. To assess the differences across male and female headed agricultural households, highlighted in the literature discussed in Section 2, we estimate equations [3] and [4] separately for the whole sample and for the samples of female and male headed households. The results are shown in Table 3 and discussed below.

¹ Given the high correlation between the receipt of coupons for fertilizers and the receipt of coupons for seeds, we could not explore the differential effect of these two policy variables; instead we joined them together.

4.2. Modeling female agricultural decision-making and its welfare consequences

As the second step in our analysis, we are interested in exploring determinants of female decision-making in agricultural production and its welfare implications. In keeping with relevant literature, we proxy welfare with the log of household level per capita expenditures, C (Glewwe and Hall, 1998; Bhaumik et al, 2006; Adams, 2004, 2006; Dimova and Wolff, 2008). Since the outcome is continuous, we can estimate an OLS model of per capita expenditures,

$$C = X_c \beta_c + \delta_c F + \varepsilon_c \quad [5]$$

where X_c is a set of explanatory variables, β_c is the associated vector of coefficients, F is a dummy variable, which takes the value of 1 if the key agricultural decision maker in the family is a woman and δ_c picks up the impact of this decision-making process on per capita expenditures. The residual ε_c is assumed to follow a normal distribution, such that $\varepsilon_c \sim N(0, \sigma_\varepsilon^2)$.

In specification [5] female decision-making is treated as exogenous. However, female decision makers are unlikely to be a randomly selected sample, i.e. $E(\varepsilon_c | F) \neq 0$. If women in a household with genuinely lower or higher per capita expenditures are selected into the decision-making process, the OLS estimates of per capita expenditures, conditional on female decision-making, will be biased. We therefore define the decision-making equation as:

$$F^* = Z_F \theta_F + \mu_F \quad [6]$$

where F^* is a latent variable measuring the propensity for a woman to be selected into the decision-making process, Z_F is a vector of explanatory variables, θ_F is the associated vector of estimates and μ_F is an error term. The latent variable F^* is unobserved, but we observe $F=1$

when $F^* > 0$ and $F=0$ otherwise. Under the assumption that μ_F follows a normal distribution, such that $\mu_F \sim N(0,1)$, the corresponding specification is a Probit model. Hence $\Pr(F = 1) = \Phi(Z_F \theta_F)$ and $\Pr(F = 0) = \Phi(-Z_F \theta_F)$, where $\Phi(\cdot)$ is the normal distribution function.

Under the assumption that (ε_C, μ_F) follow a joint normal distribution of the form $(\varepsilon_C, \mu_F) \sim N(0,0, \sigma_\varepsilon^2, 1; \rho_{CF})$, where ρ_{CF} is the coefficient of correlation, we can estimate a treatment effect model of per capita expenditures, which accounts for the possibility of non-random selection of women farmers into the decision-making process (Barnow et al, 1981). Specifically:

$$E(C | F = 1) = X_C \beta_C + \delta_C + \rho_{CF} \sigma_\varepsilon \left[\frac{\phi(Z_F \theta_F)}{\Phi(Z_F \theta_F)} \right] \text{ and}$$

$$E(C | F = 0) = X_C \beta_C + \delta_C + \rho_{CF} \sigma_\varepsilon \left[\frac{-\phi(Z_F \theta_F)}{1 - \Phi(Z_F \theta_F)} \right],$$

where $\phi(\cdot)$ is the normal density function. Hence, the difference in per capita expenditures between households where key agricultural decisions are taken by women and those where key agricultural decisions are taken by men is:

$$E(C | F = 1) - E(C | F = 0) = \delta_C + \rho_{CF} \sigma_\varepsilon \left[\frac{\phi(Z_F \theta_F)}{(1 - \Phi(Z_F \theta_F))(\Phi(Z_F \theta_F))} \right].$$

We estimate the above equation using a full maximum likelihood method and obtain unbiased estimates of β_C , δ_C and θ_F . Note that the term in the brackets is the Mills ratio. A negative value of this selectivity term is evidence in favor of overestimated levels of per capita expenditures on account of the selection of women with genuinely lower living standards into agricultural

decision-making and vice versa. The correct impact of female decision-making on per capita expenditures is computed net of the selectivity term.

5. Empirical results

5.1 Efficiency:

The upper part of Table 3 reports the input elasticities calculated from the production function part of our frontier estimates. In the lower part of Table 3, we highlight the inefficiency estimates, where a positive and significant sign of each of the explanatory variables indicates an increase in inefficiency and vice versa.

In Table 3 we provide separate efficiency estimates for the whole sample and the samples of female and male headed households (see the discussion in Section 2; this is especially relevant for the policy variables). In the first column of each case, we look at the effect of a female being a cash crop decision maker and in the second column we include policy variables at both the household and village levels. We see that in the whole sample a woman being a commercial/cash crop decision maker has a strong efficiency enhancing effect, though the opposite is true for land ownership. In contrast, when we look at the sample of female headed households, we see that it doesn't matter whether a woman makes cash crop decisions, but female ownership of land has a strong positive impact on efficiency. This is consistent with the view of White (2007) highlighted in Section 2 that males in matrilineal settings do not have incentives to invest in agricultural production. Hence, if it is a non-female headed household and a woman owns the land, it has a deteriorating effect on efficiency. Once we include policy

variables, the effect of both land and female decision-making in crops disappears; policy can counteract other household effects.

We see that the receipt of coupons has a significant efficiency improving effect only in the case of male headed households, but are insignificant in the female headed and overall samples. This is consistent with the story we tell in Section 2 that overall the policies were unsuccessful in targeting vulnerable households. When coupons were directed to poorer households such as those headed by females, bartering might have taken place to alleviate immediate consumption constraints. Extension services have a small efficiency deteriorating effect in the female headed sample, perhaps due to time allocation issues discussed above. Among the village level variables, the strongest efficiency enhancing effect is for the village development institutions. These form the catalysts through which cooperative action in the community occurs (Samuels, Sibale, and Selvester, 2009). In the case of the overall sample and the male headed sample, agricultural cooperatives have an efficiency deteriorating effect.

Note that the results on the policy variables are robust to the inclusion or exclusion of female cash crop decision-making and land ownership.

5.2 Welfare:

In Tables 4 and 5 we report the results for female selection into agricultural decision-making and the corresponding welfare effects. In Table 4 female decision-making takes the value of 1 if a woman is the key decision maker in the cultivation of cash crops such as tobacco, groundnuts and hybrid maize. In Table 5, we use a broader categorization, taking the value of 1 if a woman is the key decision maker in either cash crop or food crop cultivation.

In the per capita expenditure equation, we use a stylized specification that is popular in this type of literature (Bhaumik et al, 2006; Dimova and Wolff, 2008) and include controls such as education of the head of household (either university, secondary or vocational, the omitted category being elementary education or below), family structure including the proportions of males and females of different age groups (including household size changes nothing), various ethnicities, a dummy variable indicating whether the head of household is a female. We use the same controls in the specification of the selection equation. In addition, we have to choose excluded variables, which identify the per capita expenditure equations and the decision-making equations, are exogenous and significant in their corresponding equations, but are not significant and not included in the alternative equation.

In the case of per capita expenditures, we opt for a dummy variable which takes the value of 1 if a woman is also a key decision maker of expenditures (as distinct from production decisions) based on the income from the corresponding agricultural activities. In separate specifications, we include this variable by itself and interact it with the variable capturing the selection of a woman into the decision-making process. This will allow us to find out whether welfare is significantly affected in a situation where women take both agricultural decisions and the corresponding expenditure decisions. In the selection equation we opt for policy variables aimed at stimulating high value agricultural production as excluded conditions. These include social security assistance which is allocated to either men or women in the family, loans which are given to either females or males in the family, as well as village level variables such as the existence of a village development agency, agricultural cooperative, farmers group, women's group or a savings and credit union.

In the first case (Table 4), we look at the effect of selection into cash crop decision-making by women and its corresponding unbiased effect on welfare. We see that both female cash crop production and the corresponding decision-making on earnings have a strong positive impact on household welfare. We interact these and in the treatment effect case we see the effect amplified: if women both take cash crop decisions *and* spend the money, this has a positive impact on welfare. However, in the OLS case, the interaction term is insignificant. Since the LR test of independence doesn't pass, the OLS is the relevant case.

The selection equation provides additional insights: female land ownership has a strong positive effect on women taking cash crop decisions. The allocation of credit to women has a strong positive impact of female allocation into cash crops and the opposite is true for credit allocated to men. Village development agencies, savings and credit unions and female groups have strong positive impacts on female participation in cash crops. In so far as household variables are concerned: female headed households are more likely to be involved in cash crop production; the same is true for polygamous families, but not monogamous ones. Education has a strong positive impact on becoming a cash crop producer.

As for understanding the impact on welfare as measured by household per capita consumption, high dependency ratios negatively impact on welfare; female headed households expectedly have lower welfare; marriage is bad for welfare (whether monogamous or polygamous). Education is good for welfare.

Finally, in Table 5 we compare the results related to female decision-making in cash crop production to those related to women being involved in agro decisions in general. We see that the effect of these on welfare is negative. What has positive effect on welfare is the earnings

decision; but the interaction term is not significant. Here the relevant estimation is the treatment effect one, given that the LR test of independence passes (rejection of the null of independence). The Mills ratio is positive indicating that the welfare results are underestimated, given that women with better characteristics are allocated into agricultural decision-making. But even after netting the Mills ratio effect from the decision-making coefficient, the result is negative. The rest of the results are consistent with those of cash crop decision-making, except that now the village level infrastructure is not significant and female headship has a small positive effect on welfare.

5.3 Summarizing what works and for whom:

Pulling our results together, our focus is on the variables *cash crop decision-maker is female* and *agricultural decision-maker is female*. Women moving into commercial/cash crop production improve both welfare and efficiency. In both cases, the female cash crop decision-making variable is significant and appropriately signed.

For efficiency, the one policy with the strongest effect is the existence of functioning village development committees. In fact it “takes away” the effect of women moving into cash crop decision-making in the efficiency equation. The policy conclusion becomes: have an overall strategic approach for development of villages, rather than look at specific policies like coupons. However, for improving efficiency and promoting the movement of women into cash crops, different policies matter. For getting women into cash crop production, there is a richer story: (a) give loans to women rather than men, (b) allocate land to women (c) create financial deepening: also the village level savings-credit union variable is significant there. But these matter more for women in cash crop decision-making than in other forms of agricultural decision-making.

Is it good for women to own land? Owning land promotes female decision-making in cash crops. For efficiency, it only matters if the female is also a head of household. This is consistent with our story in the second section above: if a male is head of household and a female owns the land, the male (=husband) may feel threatened by his wife's relatives and hence not put effort into using the land appropriately.

Not only do women as cash crop decision-makers improve household welfare, but a woman being a cash crop producer and the sole decision maker in the household on what to do with the earnings amplifies this effect. The results are less robust if we look at women being either a food producer or producer of anything other than cash crops; this is a strong call for women shifting into cash crops.

6. Conclusion

We address three related questions: a) are high value cash crop activities of women more welfare enhancing than reliance on subsistence agriculture? b) if so, how do alternative interventions contribute to welfare-enhancing involvement in high value crop production by women? and, c) which interventions are most effective in reducing women's access barriers and enhancing their agricultural productivity?

Our overall results indicate that female cash crop decision-making is good for efficiency and welfare. In fact, we do find that while female agricultural decision-making generally (without allowing for control over resources derived from agricultural production) lowers welfare, female cash crop decision-making raises welfare. This brings in an important policy

dimension to the recent debate on the benefits of movement from cash crop into food crop activities in the context of food crises and chronic food insecurity in developing countries.

Despite some controversies in the literature on *de facto* matrilineal versus patrilineal land ownership, we do find that the *de jure* female ownership of land has a strong positive effect on female involvement in agriculture. However, female ownership of land improves productive efficiency only in female headed households and even there the effect disappears after controlling for other efficiency enhancing variables. In other words, our results support the view that there is scope for efficiency and welfare enhancing policy interventions, which goes beyond and countervails deeper rooted institutional factors. The strongest of these efficiency enhancing interventions across different types of households (female or male headed) is the overall village development. The results are more controversial in so far as coupons and extension services are concerned. We find that coupons improve efficiency only of male headed households, while extension services in fact deteriorate the efficiency of female headed households. This is consistent with the finding of previous research on the role of fertilizer and seed subsidies and extension services in Malawi.

Aside from female ownership of land, key policy determinants of female involvement in high value agriculture are: credit allocated to women as opposed to men, and village level infrastructure, especially village development agencies and savings and credit unions. In sum, the key to efficiency and welfare enhancing female involvement in high value agricultural production is an overall strategy of village development and improvement of the efficiency of policies related to input subsidization and extension services.

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Table 1: Production function, decision-making and intervention variables
(the reference period for all variables is the whole year: both the rainy and dry season)

<i>Production</i>	<p><i>y</i>: Total value of agricultural output. <i>m</i>: Total land size used for agricultural production in hectares. <i>l</i>: Total monthly hours of family and hired labor used. <i>k</i>: Total value of capital.</p>
<i>Decision-making</i>	<p><i>Land Ownership</i>: Whether a woman in the household owns the land or not (co-ownership is not considered). <i>Cash crop decision-maker is female</i>: Whether a woman makes the decisions concerning commercial/cash crops to be planted, input use and the timing of cropping. <i>Agricultural decision-maker is female</i>: Whether a woman makes the agricultural decisions concerning crops to be planted, input use and the timing of cropping. <i>Expenditure decision-maker is female</i>: Whether a woman makes the household expenditure decisions .</p>
<i>Person and Household Interventions</i>	<p><i>Social security aid</i>: Did anyone in the household receive social security benefits? These include a whole range of benefits, e.g. free maize, free food, cash for work program, inputs for work program, school feeding scheme, child nutrition program, scholarships, and direct cash transfers from government or NGOs. <i>Female aid</i>: Did a woman in the household receive any social security benefits? <i>Male aid</i>: Did a man in the household receive any social security benefits? <i>Female loan</i>: Did a woman in the household receive any credit? <i>Male loan</i>: Did a man in the household receive any credit? <i>Extension</i>: Did in the household receive advice on: new seed varieties, pest control, fertilizer use, pit planting, irrigation, composting, marketing/crop sales, growing or selling tobacco, access to credit? <i>Coupons</i>: Did any household member receive coupons (subsidies) for either seeds or fertilizers?</p>
<i>Village Infrastructure</i>	<p>All answer the question: Does any of the following exist in your village? <i>Village development</i>: Village development committee <i>Agro cooperative</i>: Agricultural cooperative <i>Savings and credit union</i>: Savings and credit union <i>Women's group</i>: women's group <i>Farmers group</i>: Farmers group</p>

Table 2: Women involved or not in commercial/cash crop decision-making, household descriptive statistics on determinants of choice and efficiency

Household characteristics	Female involvement in commercial/cash crops	Female involvement in non-commercial crops
<i>Socioeconomic</i>		
Female head of household	0.7811 (0.4136)	0.1282 (0.3343)
Female less than 5 years	0.3721 (0.6273)	0.5075 (0.6881)
Male less than 5 years	0.3802 (0.6332)	0.4962 (0.6828)
Female 5-15	0.7431 (0.8851)	0.7119 (0.8973)
Male 5-15	0.7398 (0.9114)	0.7009 (0.9127)
Female greater than 65	0.1808 (0.3892)	0.0721 (0.2599)
Male greater than 65	0.0337 (0.1921)	0.0803 (0.2727)
Monogamous married	0.3004 (0.4585)	0.7977 (0.4018)
Polygamous married	0.0853 (0.2794)	0.0933 (0.2908)
Head vocational education	0.0147 (0.1202)	0.0139 (0.1173)
Head university education	0.0038 (0.0616)	0.0047 (0.0686)
Head secondary education	0.1130 (0.3167)	0.1880 (0.3907)
<i>Land Ownership</i>		
Plot owned female	0.5932 (0.4914)	0.0892 (0.2850)
<i>Policy Interventions</i>		
Social security aid	0.1668 (0.3729)	0.1599 (0.3666)
Extension	0.1092 (0.3119)	0.0935 (0.2912)
Coupon fertilizer	0.6290 (0.4832)	0.5164 (0.4998)
Coupon seeds	0.6291 (0.4832)	0.5164 (0.4997)
<i>Village Infrastructure</i>		
Village development	0.9250 (0.2634)	0.8922 (0.3102)
Agro cooperative	0.1048 (0.3064)	0.0829 (0.2757)
Farmers group	0.3954 (0.4891)	0.3777 (0.4848)
Women's group	0.3102 (0.4627)	0.2778 (0.4479)
Savings and credit union	0.1233 (0.3289)	0.0924 (0.2897)
N of observations	1841	8244

Note: The figures in brackets are standard deviations.

Table 3: Estimation of household farm level efficiency

	Whole sample		Female headed sample		Male headed sample	
Production function						
Elasticity of labor	1.327829	1.313314	0.981667	1.003189	1.379126	1.364366
Elasticity of capital	0.470999	0.474518	0.623424	0.631699	0.438177	0.436796
Elasticity of land	1.459459	1.485231	1.502392	1.578816	1.495787	1.518379
Cash crop decision-maker is female	-0.5376* (0.3030)	0.4545 (0.5581)	-27.4788 (1071.017)	-0.6041 (0.6787)	-0.0917 (0.5924)	0.2057 (1.0555)
Plot owned female	0.6217*** (0.1764)	0.6723 (0.4634)	-0.7961* (0.4664)	0.6217 (0.4328)	-22.7831 (1095.635)	-32.1015 (1.60e+07)
Extension		0.1364 (0.7397)		1.7679* (1.0884)		-0.7852 (1.0315)
Coupons		-0.9969 (0.6669)		-0.5129 (0.7901)		-1.1651* (0.7196)
Village development		-4.8383*** (1.2894)		-4.2426*** (1.4051)		-3.4658*** (0.8256)
Agro cooperative		3.3316*** (0.7267)		1.5708 (1.0139)		4.6165*** (0.8006)
Savings and credit union		-12.3631 (108.277)		0.0022 (1.0257)		-34.5971 (6824.15)
Women's group		-0.8062 (0.9535)		1.0046 (0.7124)		-2.7036 (2.5061)
Farmers' group		-0.9601 (0.9069)		1.0249 (0.9640)		-28.9247 (2963.87)
N obs	10085	10085	2495	2495	7590	7590

Note: ***, ** and * indicate significance at the 1%, 5% and 10% level, respectively. The figures in brackets are standard errors. Elasticities of the frontier production function are calculated as $E_m = \beta_1 + \beta_4 m + \beta_7 l + \beta_8 k$, $E_l = \beta_2 + \beta_5 l + \beta_7 m + \beta_9 k$, and $E_k = \beta_3 + \beta_6 k + \beta_8 m + \beta_9 l$.

Table 4: Female cash crop participation and welfare consequences

	Treatment effect model				OLS	
	Welfare	Participation	Welfare	Participation	Welfare	Welfare
Constant	7.939*** (0.0325)	-1.9372*** (0.0993)	7.9393*** (0.0325)	-1.9375*** (0.0993)	7.9448*** (0.0322)	7.9449*** (0.0322)
Female head of household	-0.3296*** (0.0566)	1.7289*** (0.0741)	-0.3351*** (0.0567)	1.7297*** (0.0742)	-0.2759*** (0.0326)	-0.2786*** (0.0327)
Female less than 5 years	-1.1438*** (0.0608)	-0.0955 (0.1441)	-1.1443*** (0.0608)	-0.0950 (0.1441)	-1.1445*** (0.0608)	-1.1451*** (0.0608)
Male less than 5 years	-1.1172*** (0.0609)	-0.1511 (0.1426)	-1.1184*** (0.0609)	-0.1505 (0.1426)	-1.1196*** (0.0809)	-1.1208*** (0.0609)
Female 5-15	-1.0850*** (0.0514)	0.1117 (0.1157)	-1.0847*** (0.0514)	0.1120 (0.1157)	-1.0830*** (0.0514)	-1.0826*** (0.0514)
Male 5-15	-1.2979*** (0.0519)	0.2826** (0.1184)	-1.2988*** (0.0519)	0.2831* (0.1184)	-1.2932*** (0.0518)	-1.2939*** (0.0518)
Female greater than 65	-0.7325*** (0.0584)	-0.1317 (0.1058)	-0.7316*** (0.0746)	-0.1313 (0.1058)	-0.7407*** (0.0580)	-0.7402*** (0.0580)
Male greater than 65	-0.7213*** (0.0746)	-0.1175 (0.2266)	-0.7315*** (0.0746)	-0.1172 (0.2266)	-0.7307*** (0.0746)	-0.7309*** (0.0746)
Monogamous married	-0.0962*** (0.0143)	0.0246 (0.0324)	-0.0964*** (0.0198)	0.0248 (0.0324)	-0.0962*** (0.0143)	-0.0964*** (0.0143)
Polygamous married	-0.0926*** (0.0143)	0.1873*** (0.0437)	-0.0933*** (0.0198)	0.1873*** (0.0437)	-0.0903*** (0.0197)	-0.0909*** (0.0197)
Head vocational education	1.1999*** (0.0645)	0.2468* (0.1470)	1.1999*** (0.0646)	0.2470* (0.0437)	1.2038*** (0.0645)	1.2041*** (0.0645)
Head university education	1.6830*** (0.1135)	0.4542* (0.2564)	1.6816*** (0.1135)	0.4543* (0.2564)	1.6884*** (0.1135)	1.6873*** (0.1135)
Head secondary education	0.5514*** (0.0207)	0.1497*** (0.0519)	0.5515*** (0.0207)	0.1499*** (0.0519)	0.5535*** (0.0206)	0.5536*** (0.0206)
Ethnicities	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Expenditure decision-maker is female	0.0868* (0.0499)		0.1721** (0.0843)		0.0873* (0.0499)	0.1690** (0.0844)
Cash crop decision-maker is female	0.1885** (0.0899)		-0.1308 (0.1042)		0.0880*** (0.0244)	0.0943*** (0.0250)
Expenditure decision-maker is female * Cash crop decision-maker is female			0.2001** (0.0904)			-0.1254 (0.1043)
Plot owned female		0.2259*** (0.0609)		0.2252*** (0.0609)		
Female aid		0.0558 (0.0684)		0.0557 (0.0629)		
Male aid		-0.0663 (0.0697)		-0.0658 (0.0697)		
Female loan		0.4172*** (0.0684)		0.4181*** (0.0683)		
Male loan		-0.2918*** (0.0867)		-0.2917*** (0.0867)		
Village development		0.1651** (0.0664)		0.1644** (0.0664)		
Agro cooperative		0.0720 (0.0617)		0.0718 (0.0617)		
Farmers' group		0.0035 (0.0389)		0.0035 (0.0389)		
Savings-credit union		0.1520*** (0.0583)		0.1525*** (0.0583)		
Women's group		0.1054** (0.0423)		0.1059** (0.0422)		
Mills ratio	-0.0566		-0.0593			
LR test of independence	Chi2(1)=1.33 Prob>chi2=0.2487		Chi2(1)=1.46 Prob>chi2=0.2272			
Adj Rsq					0.2358	0.2359
N obs	10085	10085	10085	10085	10085	10085

Table 5: Female agricultural participation and welfare consequences

	Treatment effect model				OLS	
	Welfare	Participation	Welfare	Participation	Welfare	Welfare
Constant	7.9854*** (0.0337)	-2.2797*** (0.2784)	7.9855*** (0.0337)	-2.2799*** (0.2783)	7.9597*** (0.0326)	7.9597*** (0.0326)
Female head of household	0.2652* (0.1442)	4.1723*** (0.1739)	0.2640* (0.1443)	4.1723*** (0.1739)	-0.0901 (0.0807)	-0.0914 (0.0808)
Female less than 5 years	-1.1338*** (0.0609)	0.3232 (0.4701)	-1.1341*** (0.0609)	0.3227 (0.4701)	-1.1421*** (0.0609)	-1.1324*** (0.0609)
Male less than 5 years	-1.1055*** (0.0611)	0.9754** (0.4910)	-1.1056*** (0.0611)	0.9762** (0.4910)	-1.0778*** (0.0514)	-1.1171*** (0.0610)
Female 5-15	-1.0687*** (0.0515)	0.2443 (0.3539)	-1.0688*** (0.0515)	0.2443 (0.3539)	-1.0778*** (0.0514)	-1.0779*** (0.0514)
Male 5-15	-1.2765*** (0.0519)	0.4332 (0.3725)	-1.2766*** (0.0581)	0.4327 (0.3726)	-1.2856*** (0.0518)	-1.2857*** (0.0518)
Female greater than 65	-0.7335*** (0.0581)	0.1074 (0.3148)	-0.7337*** (0.0581)	0.1073 (0.3148)	-0.7435*** (0.0580)	-0.7437*** (0.0580)
Male greater than 65	-0.7459*** (0.0748)	-0.2490 (0.5338)	-0.7459*** (0.0748)	-0.2493 (0.5339)	-0.7347*** (0.0747)	-0.7346*** (0.0747)
Monogamous married	-0.1178*** (0.0155)	-0.7019*** (0.0615)	-0.1179*** (0.0155)	-0.7019*** (0.0615)	-0.1024*** (0.0146)	-0.1024*** (0.0146)
Polygamous married	-0.1102*** (0.0207)	-0.5832*** (0.1045)	-0.1104*** (0.0207)	-0.5831*** (0.1045)	-0.0945*** (0.0199)	-0.0946*** (0.0199)
Head vocational education	1.2019*** (0.0645)	-0.5758 (0.4020)	1.2020*** (0.0645)	-0.5759 (0.4020)	1.2059*** (0.0645)	1.2061*** (0.0645)
Head university education	1.6951*** (0.1135)	0.5157 (0.7808)	1.6939*** (0.1135)	0.5155 (0.7807)	1.6934*** (0.1135)	1.6922*** (0.1136)
Head secondary education	0.5539*** (0.0206)	-0.2513 (0.1960)	0.5538*** (0.0206)	-0.2512 (0.1959)	0.5548*** (0.0206)	0.5547*** (0.0206)
Ethnicities	Yes***	Yes***	Yes***	Yes***	Yes***	Yes***
Expenditure decision-maker is female	0.1084** (0.0496)		0.1362 (0.1009)		0.1068** (0.0498)	0.1349 (0.1012)
Agricultural decision-maker is female	-0.5521*** (0.1572)		-0.5501*** (0.1573)		-0.1563* (0.0835)	-0.1541* (0.0837)
Expenditure decision-maker is female * Agricultural decision-maker is female			-0.0366 (0.1157)			-0.0370 (0.1161)
Plot owned female		0.6931*** (0.1264)		0.6930*** (0.1264)		
Female aid		0.2133 (0.1973)		0.2135 (0.1974)		
Male aid		-0.6028*** (0.2137)		-0.6025*** (0.2137)		
Female loan		0.5493** (0.3599)		0.5490** (0.2557)		
Male loan		-0.6764* (0.3599)		-0.6767* (0.3599)		
Village development		-0.1870 (0.2227)		-0.1867 (0.2227)		
Agro cooperative		-0.1452 (0.1761)		-0.1452 (0.1761)		
Farmers' group		-0.1452 (0.1761)		-0.1246 (0.1211)		
Savings-credit union		0.1385 (0.2059)		0.1387 (0.2059)		
Women's group		0.1488 (0.1339)		0.1488 (0.2783)		
Mills ratio	0.2173		0.2174			
LR test of independence	Chi2(1)=7.52, Prob>chi2=0.0061		Chi2(1)=7.51, Prob>chi2=0.0061			
Adj Rsq						
N obs	10085	10085	10085	10085	10085	10085