

Gender and Agriculture

Inefficiencies, Segregation, and Low Productivity Traps

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Abstract

Women make essential contributions to agriculture in developing countries, where they constitute approximately 43 percent of the agricultural labor force. However, female farmers typically have lower output per unit of land and are much less likely to be active in commercial farming than their male counterparts. These gender differences in land productivity and participation between male and female farmers are due to gender differences in access to inputs, resources, and services. In this paper, the authors review the evidence on productivity differences and access to resources. They discuss some of the reasons for these differences, such as differences in property rights, education, control

over resources (e.g., land), access to inputs and services (e.g., fertilizer, extension, and credit), and social norms. Although women are less active in commercial farming and are largely excluded from contract farming, they often provide the bulk of wage labor in the nontraditional export sector. In general, gender gaps do not appear to fall systematically with growth, and they appear to rise with GDP per capita and with greater access to resources and inputs. Active policies that support women's access and participation, not just greater overall access, are essential if these gaps are to be closed. The gains in terms of greater productivity of land and overall production are likely to be large.

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Gender and Agriculture: Inefficiencies, Segregation, and Low Productivity Traps¹

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Introduction

As farmers and through their labor on family farms, other farms, and agricultural enterprises, women make essential contributions to agriculture in developing countries. Women make up approximately 43 percent of the agricultural labor force of developing countries, ranging from approximately 20 percent in Latin America to almost 50 percent in Eastern and Southeastern Asia and Sub-Saharan Africa (FAO, 2011). However, women in agriculture often have lower levels of output per unit of land (which we will refer to hereafter as yield) than their male counterparts. This situation results from women's lower command over resources due to a range of institutional- and norm-based constraints. In addition, fewer women than men engage as principal claimants in the most profitable aspect of agriculture, commercial production.

In this paper, we argue that this agricultural "segregation" is indicative of a low-productivity trap: women's lower access to resources explains their low participation in commercial or export agricultural production, which limits their ability to accumulate resources. This is not an intractable cycle. The constraints that cause women's lack of access to and accumulation of resources and their inability to participate fully in commercial agriculture do not completely overlap, and some of these constraints are amenable to policy interventions.

This paper is organized as follows. Section 2 provides an overview of the differences in male and female productivity within predominantly food crops. Section 3 discusses the major elements needed for production, documents the male-female gap, and explores the existing evidence on why these gaps exist. Section 4 concludes.

Male–Female Yield Differences and Production Efficiency

Women often achieve lower yields than men in agriculture.¹ In Burkina Faso, Udry et al. (1995) and Udry (1996) find that within the same household, women’s yields were 18 percent lower than the yields of men. Akresh (2005) confirms these results for the same area. In Ghana, Goldstein and Udry (2008) find that women had far lower yields, resulting in far lower profits per hectare, than their husbands who farmed the same crops. These studies provide stark evidence of male and female yield differentials. Using the farming system of West Africa, in which women and men of the same household often farm different plots of land, these studies identify yield differentials *within* households, thereby accounting for all of the market conditions and imperfections faced by the household as a whole. Moreover, these studies provide evidence that even within a household, households cannot or will not act to overcome the root causes of women’s lower yields.

For broader evidence on gender differences in yields, we can turn to studies that compare yields for male- and female-headed households. Here, evidence from a number of studies points to lower yields on farms run by women. For example, using data from Ethiopia, Tiruneh et al. (2001) find that female-headed households have 35 percent lower value of output per hectare than males. In Zimbabwe, Horrell and Krishnan (2007) find lower yields for households of widows or de jure female-headed households.

However, these patterns are not universal. A number of studies find no statistically significant differences in yields between men and women farmers. For example, in Burkina Faso, the study cited previously by Akresh (2005) finds that male and female yield differentials vary by region; that study finds differences in some regions, but not in others.

Masterson (2007) finds no yield differences in Paraguay among female- and male-headed farm households. Moreover, it should be noted that studies that compare male- and female-headed households (as opposed to Akresh (2005) and others who compare yields within households) are faced with a number of problems, not least of which is the fact that male- and female-headed households may approach agriculture in fundamentally different ways (that is, they may have different production functions for the same crops).

However, yield differences are only part of the story. What is more telling is that in the significant number of studies showing male and female yield differences, these differences almost always disappear when the level of access or usage of the factors of production are taken into account.² Some examples come from the evidence examined above. Udry et al. (1995) find that the female yield differential in Burkina Faso is due to lower levels of labor and fertilizer usage. Horrell and Krishnan (2007) find that gender yield differentials for cotton in Zimbabwe stem from a lack of access to extension, lack of experience, and lack of fertilizer. Evidence from Tiruneh et al. (2001) in Ethiopia also demonstrates that differences in extension and levels of inputs are responsible for gender differences in the value of output per hectare. Studies outside of Africa are much less common, but evidence from China shows that women-run farms earn at least as much revenue on their plots as do farms run by men. The conclusion is that there are no differences between men and women farmers in terms of economic efficiency (de Brauw et al., 2008).³

Some studies consider profit efficiency, which may include both allocative efficiency and farmers' production efficiency.⁴ For example, Adesina and Djato (1997) report yield differences between farms managed by women and by men in Cote d'Ivoire, but when they

account for all factors of production, women and men are found to have equally high production and allocative efficiency. Finally, the study by Goldstein and Udry (2008), mentioned above, finds differences in yields and profit per hectare but suggests that these differences are explained by differences in tenure security.⁵

The evidence provided by these and other studies point to an overriding conclusion: women are not worse farmers than men in a technical sense (and the little existing evidence suggests that women allocate resources just as efficiently as men). Rather, women often face constraints in their access to and demand for the factors of production that would allow them to have yields equal to men. We now turn to an examination of the magnitudes and causes of these gaps.

Lower Access to Factors of Production: Magnitude and Causes

The following discussion considers the main elements needed for agricultural production and explores whether there are gender gaps and the magnitude and causes of these gaps. Almost all of this discussion focuses on comparing male- and female-headed households because this is typically how the data are structured. The data are structured this way because it is an expedient way to collect data and because, in much of the world, the farm is a household enterprise, and it is difficult to assign ownership and responsibility to only one person.⁶ The data used in this paper are drawn from the Rural Income Generating Activities (RIGA) database.⁷

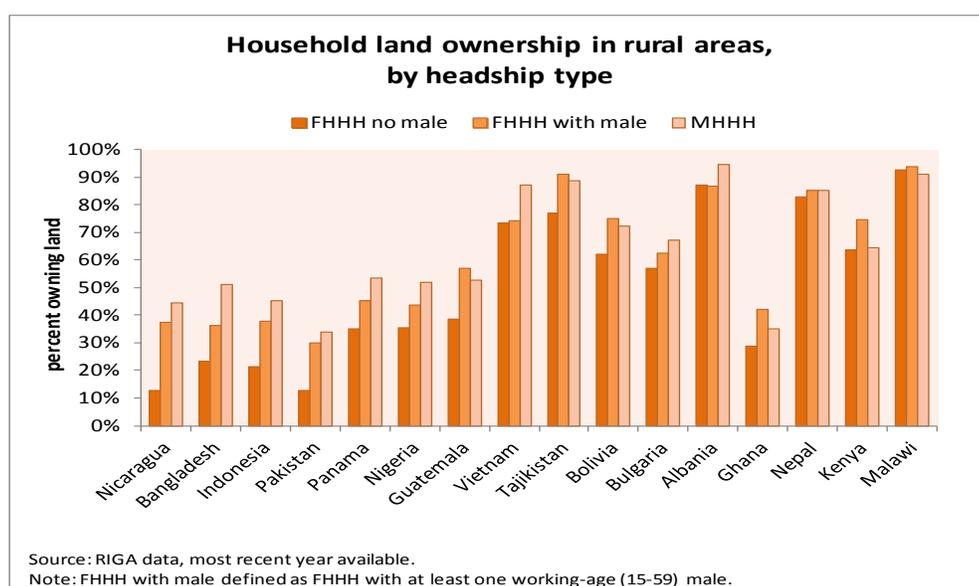
It is important to note that female-headed households are a heterogeneous group of households that include women whose husbands have migrated, women who are divorced, and women who are widows as well as some households that are classified as female-

headed even though the husband is present. In an attempt to nuance the definition of female-headed households to account for some of this heterogeneity, we disaggregate female-headed households into two categories: (i) those in which a male of labor age (15–59) is present and (ii) those with no male of labor age. Where appropriate, we use this breakdown to present our results. As expected, the gaps are more pronounced among female-headed households without a male presence than among those with a male presence.

Land

In all regions and in many countries, women have less access to land than men do.⁸ For the 16 countries for which we have data, rural, female-headed households are more likely to own land than their male counterparts in only six countries (fig. 1).⁹ These differences are much more pronounced in households without a labor-age male present, and they do not systematically decrease with GDP per capita (not shown in fig. 1).

Figure 1



Not only are female-headed households less likely to own land, but, conditional on owning any land, female-headed households also own less land than do their male counterparts, as shown in figure 2. This phenomenon may be explained by the typically smaller size of female-headed households. Figure 3 shows the gap in the size of owned land divided by the number of household members aged 15–59, conditional on these households owning any land. This gap seems to narrow when we consider the pool of household labor.

Figure 2

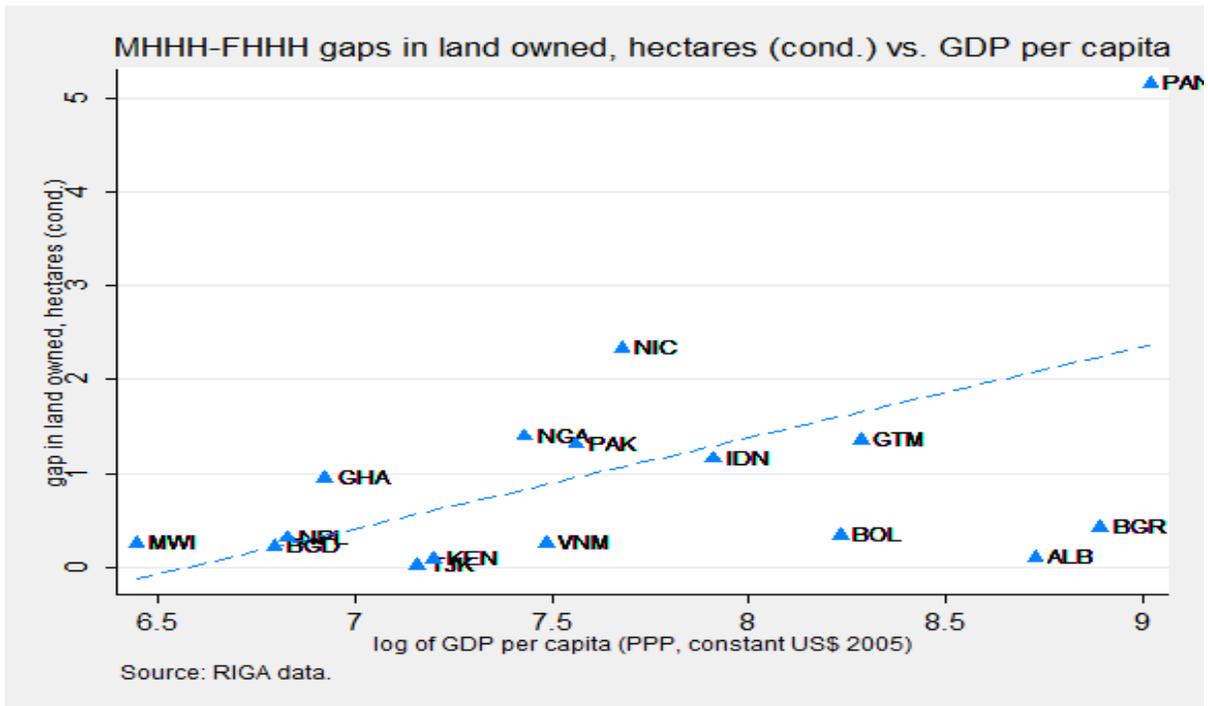
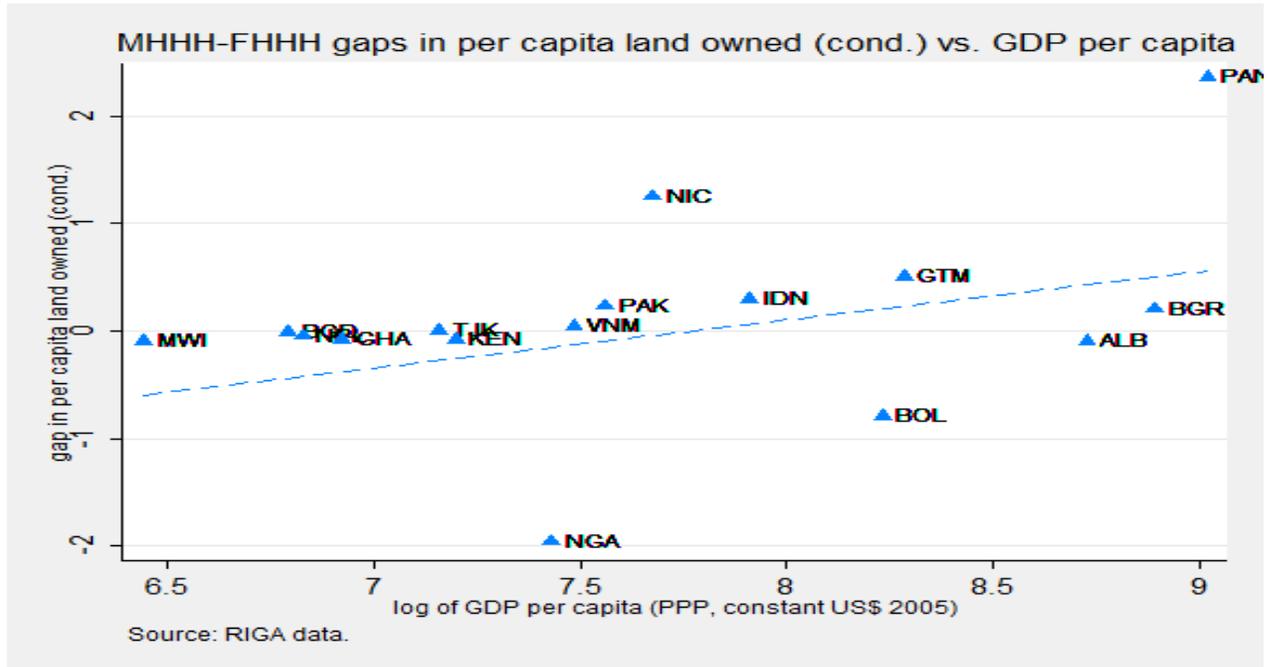
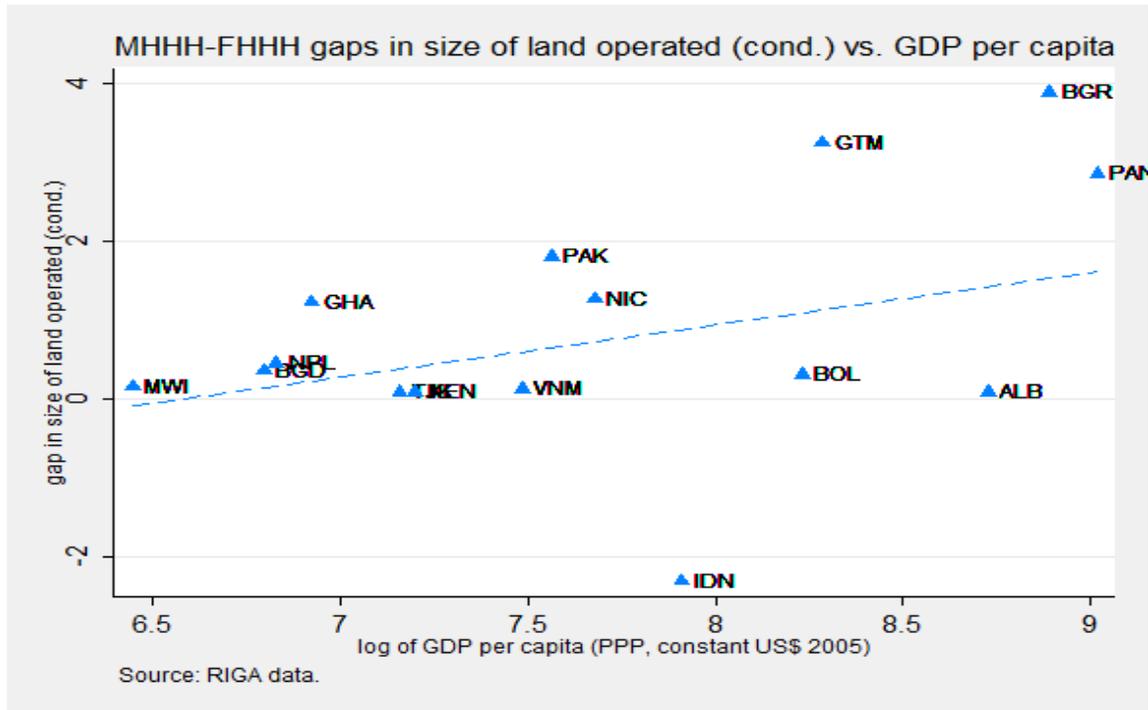


Figure 3



Ownership of land is crucial, in many cases, for weathering shocks and accessing credit and for potentially safeguarding investment and crops from expropriation. However, a broader measure of access to land involves land that is operated by female-headed households. Female-headed households are less likely to operate land in approximately half of the countries for which we have data. Similar to land ownership, in most countries, when rural, female-headed households operate land, they operate smaller farms than male-headed households do.¹⁰ This trend can be seen in figure 4, which shows the gap in the size of land operated by male- and female-headed households, conditional on these households operating any land.

Figure 1



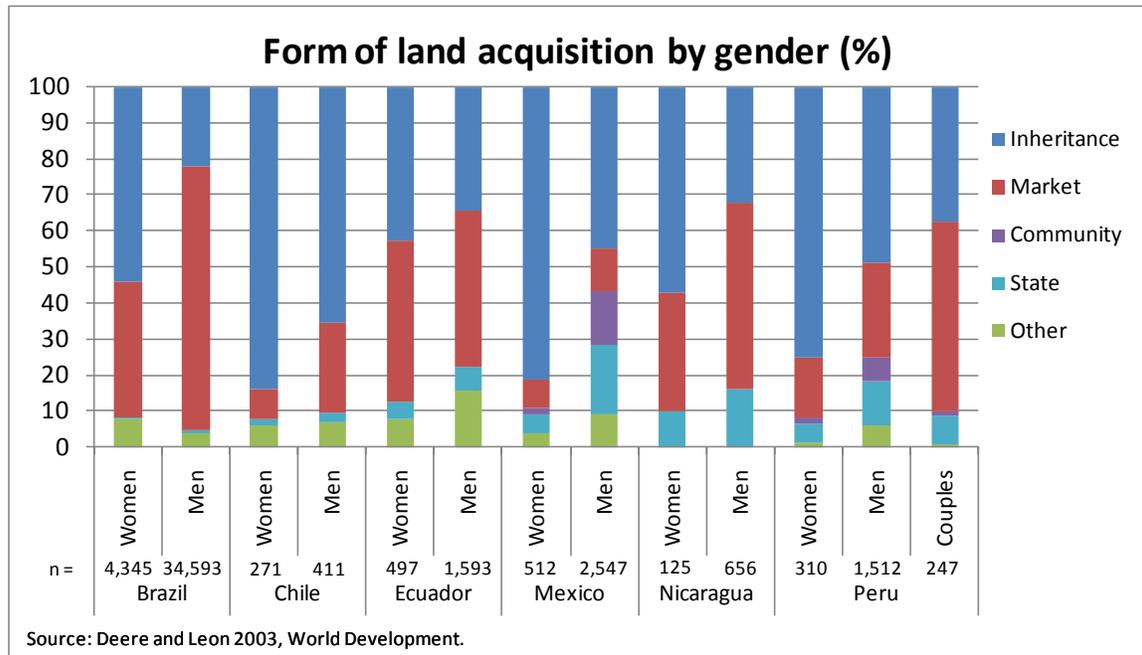
The smaller scale of these farms is due to not only lower access to a number of inputs (including, but not limited to, labor; see the discussions below) but also the ways in which women acquire land. We will consider this issue following the discussing of the quality of land women own or operate.

One often-cited argument is that even when women own land, it is of poor quality.¹¹ However, the evidence for this argument is inconsistent, and the little existing evidence does not provide a clear picture. Goldstein and Udry (1999) find that women in Southern Ghana farm land with lower organic matter levels but no significant difference in pH. In contrast, Fuentes (2008) uses data from Peru and finds no evidence that women have worse quality land in terms of salinization and erosion. De Brauw et al. (2008) find no difference in (seemingly self-reported) land quality in women-controlled and other plots. Udry (1996) uses data from Burkina Faso and does not find that women's plots are of lower

quality. This evidence is quite limited; no studies examine a broad range of soil quality measures or the gender of the owners.

What factors underlie women’s poorer access to land? To begin this discussion, figure 5 shows how individuals in Latin America acquire the land that they own.

Figure 5



It is evident, first, from the numbers above each country’s name that women are less likely to own land. Second, for the land that women own, inheritance is the major source of land acquisition for both men and women (with the exception of men in Brazil). However, inheritance is much more important for women than for men. Men in almost all countries are more likely than women to receive land from the community, state, and market (with the exception of Ecuador). Thus, although men are more likely to inherit land in absolute terms, in relative terms, inheritance is a more important source of land acquisition for women.

These countries in Latin America provide an interesting case for understanding women's lower access to land because inheritance laws do not preclude the inheritance of land by girls and women. Nonetheless, although legal restrictions may be the same, individuals' preferences for how to allocate their estates may perpetuate gender imbalances. Deere and León (2003) present data from a review of wills in Mexico and show that partners are selected to inherit land 38.5 percent of the time; daughters, 8.8 percent of the time; and sons, 38.8 percent of the time. Sons and partners are the predominant choice, with daughters a very distant third. Deere and León argue that a number of factors suggest improvements in the likelihood that women will inherit land (for example, joint titling, discussed below), but this pattern of inheritance indicates worsening inequality in women's access to land across generations, all else equal, given that women choose their daughters as sole heirs only 19 percent of the time (compared to 5 percent for men).¹²

Women are also less likely to acquire land from the state, which mostly takes the form of land redistribution programs. Deere and León (2001, table 3.2) show that the fraction of beneficiaries of 13 Latin American land reform programs who were women was approximately 11–12 percent. The main reason for this situation is likely to be the institutional arrangement of these programs: they target household heads (which have previously been identified solely identified as male) and sometimes restrict households to one beneficiary, making men much more likely to benefit. However, this situation can be rectified with policy reform. For example, Deere and León (2003) document that in Colombia, the share of female beneficiaries from agrarian reform increased from 11 to 45 percent after joint titling for land parcels was mandated and enforced. Finally, the market is

a less common source of land for men (with the exception of Ecuador, where it is roughly as common for men as for women).

Why do women participate less in the market for land? Given that women are probably less likely to fare well in inheritance and state programs, the market should arguably be a more important source of land for women. A number of other constraints come into play, which are discussed elsewhere in this paper as well as in this section.

One possible explanation for women's lower participation in the market is that it reflects a cash constraint. Women are less likely to have credit, including credit devoted to land (see the discussion below). When this lack of credit is combined with lower earnings, women may be less likely to be able to afford this lumpy asset. The smaller scale of women's farm enterprises is reinforced by the fact that their lack of access to cash hampers their ability to buy certain inputs, as discussed below.

Given these cash or credit constraints, one option that would allow these constraints to be less binding would be for women to use rental markets. However, data for 15 countries show that women rely less than men on the market for rentals and typically have a lower share of operating land from rental markets.

It is important to remember that ownership is a critical part of this issue and is complemented by individuals' ability to *protect* these rights. An example of this is provided in a study on Ghana by Goldstein and Udry (2008), who show that women's lower yields can be traced to the fact that they fallow their land for shorter periods of time, which, in turn, is related to political connections: individuals with stronger ties to the political hierarchy that administers land (among other things) are less subject to the risk of

expropriation. Women are less politically connected than men, and this institutional constraint leads to their lower yields.

The fact that women have weaker rights over the land they farm potentially explains why we see women not only owning but also renting less land. When these rights are strengthened, there are likely to be significant pay offs. For example, a recent paper (Ali, Deininger, and Goldstein, 2011) shows that when land rights are strengthened for both men and women in Rwanda, higher investment results. For male-headed households, investments in soil and water conservation (which are critical given the intensive use of land in Rwanda) increase by approximately 9 percent, but for female-headed households, these investments increase by 18 percent.

Fertilizer

Across countries, we can see that male-headed households are more likely to use chemical fertilizer (a purchased input) than are female-headed households (fig. 6). This gap is more severe for female-headed households without a male presence in nearly all of the countries for which we have data, as shown in figure 7. The relationship between this gap and GDP per capita is not clear.

Figure 6

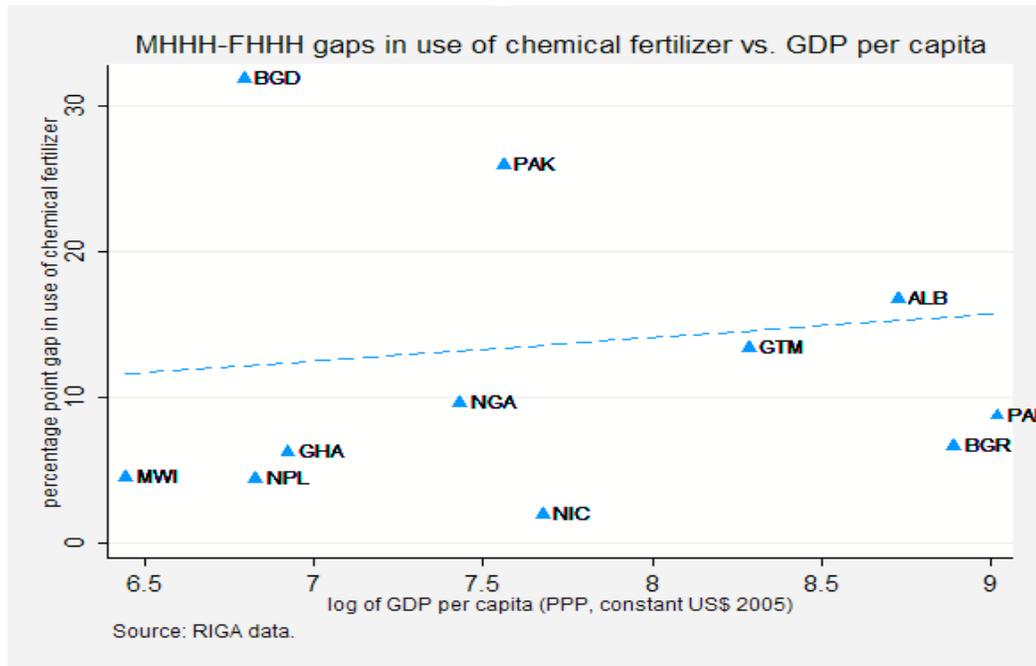
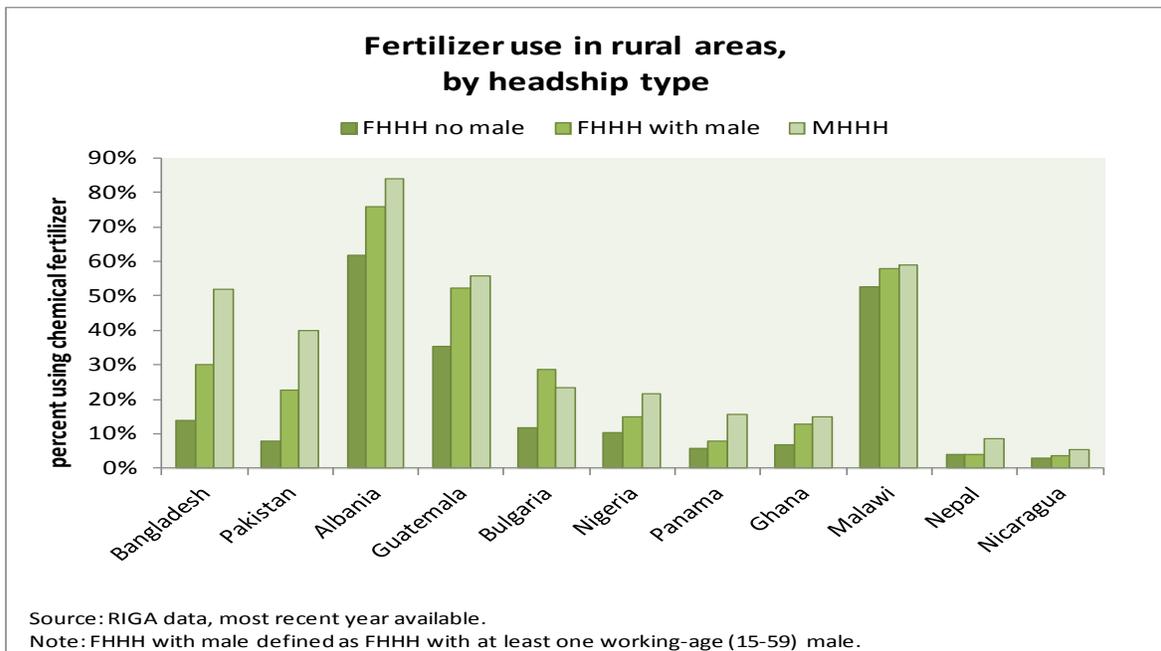


Figure 7



Evidence from other countries comes from Gilbert, Sakala, and Benson (2002), who find that in Malawi, male heads of household have significantly higher fertilizer use, cash crop area and total field area than female farmers, indicating higher levels of land, labor, and cash available to male farmers. Moock (1976) examines Kenya and finds that women use smaller bundles of physical inputs, especially store-purchased inputs, than do their male counterparts. Women use noticeably less chemical fertilizer, on average, and are less likely to plant a hybrid seed variety or to use insecticides.

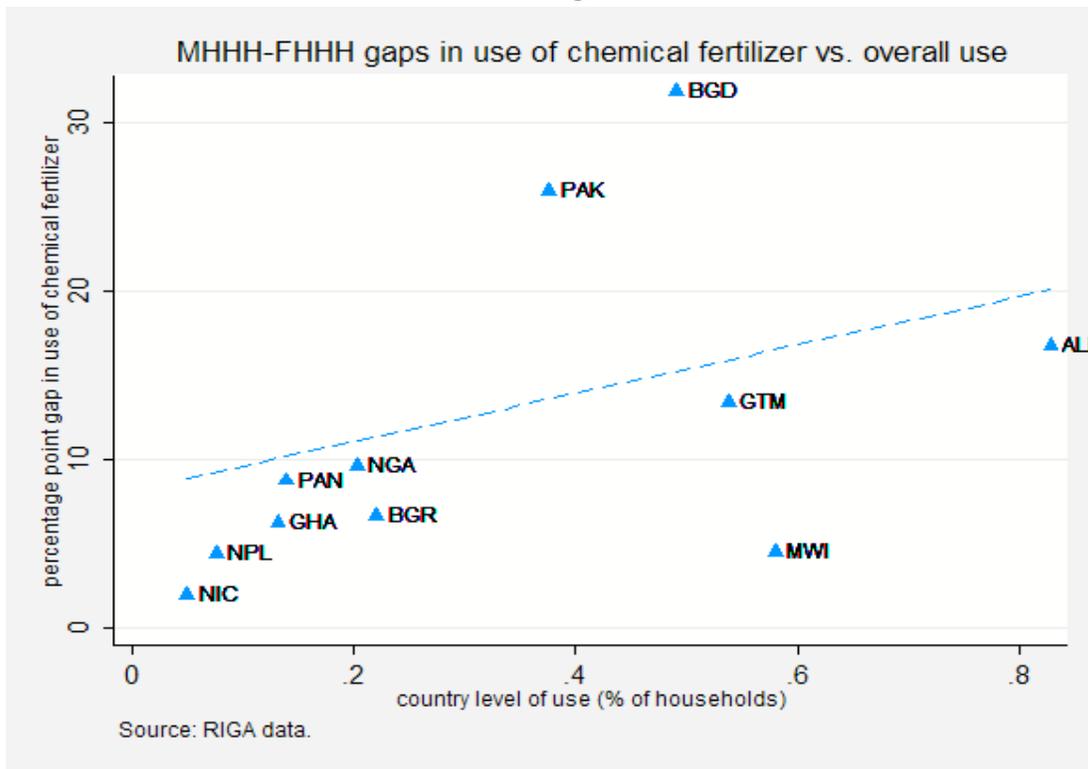
Udry et al. (1995) examine households in Burkina Faso and show that plots controlled by women are farmed less intensively than plots controlled by men, and virtually all fertilizer is concentrated on plots controlled by men. Uttaro (2002) uses data from Malawi and finds that women's marital status affects their use of fertilizer. As a group, married women are more likely to use fertilizer than are female-headed households by a margin of 62 percent to 45 percent. Indeed, married women are fairly close to the level of married men, 67 percent of whom are able to afford fertilizer.

For purchased inputs overall, Peterman, Behrman, and Quisumbing (2010) review 20 studies from the last decade on gender differences in the use of technological inputs (inorganic fertilizer, insecticide, improved seed varieties, and mechanical power). They find that in 16 out of 20 studies, men use more of these inputs than women, whereas in the other four studies, women use more of these inputs.

Returning to the cross-country data, an interesting pattern is that the gap between male- and female-headed households seems to *increase* with higher overall use of fertilizer in a country, as shown in figure 8. This finding suggests that this is not simply a problem of

market penetration (e.g., women use less fertilizer when markets are thin, perhaps because of economies of scale).

Figure 8



There are a number of potential explanations for women’s lower use of fertilizer, including the inability to raise the necessary cash for fertilizer purchases, the fact that female farmers are disproportionately engaged in staple crops (i.e., crops that constitute the dominant part of the diet and supply a major proportion of energy and nutrient needs) as opposed to cash crops (i.e., crops grown for sale for profit and not own consumption), and the lack of information due to lower levels of education and access to extension. A final explanation may stem from economies of scale. We discuss these issues in turn (with the exception of education or extension, which we cover in a later section).

With respect to fertilizer, one piece of evidence that this input may be a binding constraint comes from a study on Uganda. Dolan (2004) finds that one of the most prominent barriers to increased agricultural activity is a lack of financial capital. Nearly all female-headed households reported a desire to expand agricultural activities but lacked the money to purchase land and inputs (seeds, fertilizer, pesticides) or to hire the labor needed to assist them. Credit constraints were also cited as a potential reason for the low uptake of fertilizer, even when it was subsidized in Malawi (SOAS et al., 2008). Due and Gladwin (1991) document the difference in overall fertilizer use and intensity in Malawi (approximately 50 percent more per hectare) and argue that social constraints prevent women from participating in the institutions (farmer clubs) that would provide them with access to credit. When land size and credit or cash are controlled, gender is not a significant determinant of demand for fertilizer.

As we will discuss below, women are less likely to farm cash crops (or are less likely to sell their produce at all). Therefore, the use of fertilizer may not be worthwhile. In itself, this finding does not indicate a problem with markets or institutions per se, but there is an underlying phenomenon in which women engage less in marketable agriculture. However, it is important to note that differences in fertilizer use (e.g., in Malawi and Burkina Faso) seem to persist even when men and women farm the same crop.

Finally, there are likely to be economies of scale for fertilizer. At one level, these issues of scale result because the time needed to procure knowledge and the fertilizer itself (e.g., significant transport costs) are nondivisible costs that may not make fertilizer economical for very small-scale farms, which are the type of farms women are more likely to have.

The issue of scale may also give rise to a possible market failure. Fertilizer is commonly sold in 50 kg bags, which are not only heavy and require significant labor to transport but also exclude a significant swath of small farms and, as a result of credit constraints and issues of fertilizer storage, another significant group, women farmers. Thus, the solution would seem to be to sell fertilizer in smaller bags. However, this solution produces another set of problems. First, the labor required to bag fertilizer is multiplied; added to the costs of the bags, this raises the unit cost of the fertilizer. Second, Uttaro (2002) documents that in Malawi, traders have a tendency to adulterate this locally repackaged fertilizer (as opposed to the 50 kg imported bags) with sand, thus creating a quality or monitoring problem. The bottom line is that women with smaller landholdings suffer disproportionately from these divisibility issues and are likely to face higher unit costs than men. These types of issues may explain why we see persistent gender gaps even when the fraction of men using fertilizer is increasing (indicating an expansion of the fertilizer market), as shown in figure 8 above. Ultimately, the market should resolve these economy of scale issues, but it is likely that in many countries, markets are still thin enough to allow them to persist.

Additional research is needed to understand which of these constraints on women farmers' use of fertilizer are the most binding. It seems clear that these constraints are important, but more work is needed to identify precisely which constraints are relevant in which contexts. For example, drawing upon data from both Malawi and Benin, Minot, Kherallah, and Berry (2000) show that female-headed households are less likely to use fertilizer in Malawi but are about equally as likely to use fertilizer in Benin. However, conditional on the use of fertilizer, women use less per hectare in both countries. These authors' regression analysis of the determinants of fertilizer use controls for many of the

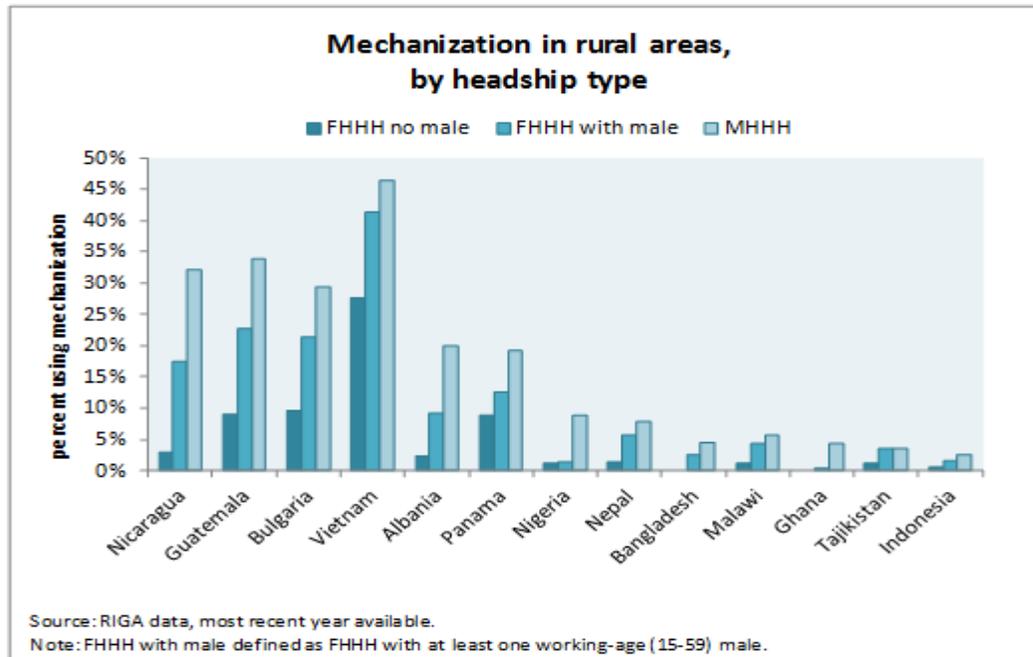
constraints discussed above, and the gender variable is insignificant. However, it is not clear whether this result is due to household, market, crop choice, or other factors.

Understanding which constraints are the most binding is important because government programs to provide fertilizer are likely to underserve women. For example, evidence from a fertilizer coupon program in Malawi (SOAS et al., 2008) shows that female-headed households are significantly less likely than male households to receive a fertilizer coupon. In one region, female-headed households were 11 percentage points less likely to receive this coupon (SOAS et al., 2008, p 63). The authors of the report cite a number of potential explanations for the underserving of women, including credit constraints (farmers had to pay a nontrivial amount for fertilizer), time constraints (farmers had to queue for up to a week to receive the coupons), and poor targeting, which lowers women's demand and access to fertilizer. However, a properly targeted program may be able to overcome these constraints and redress the issue of women's lower yields. Gilbert, Sakala, and Benson (2002) examine an intervention to provide women (and men) with fertilizer and improved seeds in Malawi and find that when women are provided with these inputs, their yields do not differ from those of men.

Mechanization

As shown in figure 9, across countries, we find significant gaps between male and female use of mechanization.¹³ These gaps are more severe for female-headed households without a male presence in nearly all of the countries for which we have data.

Figure 9



A potential argument is that physical constraints prevent women, who tend to have limited upper-body strength (see, for example, Alesina, Giuliano, and Nunn, 2011), from engaging in the use of mechanization, particularly when “mechanization” means animal traction. However, returning to figure 9 above, we can see that the gap between male- and female-headed households is higher in higher-income countries. All else equal, these countries are more likely to have tractor-driven agriculture. Hence, the strength argument is less binding (if it is binding at all).

These figures refer to countries where mechanization involves motorized equipment. In countries with animal traction, social norms appear to play a role. For example, Pender and Gebremedhin (2006) find that women use significantly less draft power per hectare than men in the Tigray region of Ethiopia. They explain this finding as follows: “The prohibition against women plowing and threshing is a long-standing one that, according to Bauer

(1977), is based on ‘an indigenous theory that their participation in these activities would decrease the amount of crops produced’ (Bauer 1977, p. 98).” These attitudes may be changing in Tigray; some female-headed households have had the desire and the courage to challenge such norms, although this challenge can be difficult and these women may be subject to ridicule or intimidation (Abay et al., 2001; Pender and Gebremedhin, p. 138). It is possible that these norms regarding animal traction have extended to the use of machines.

One might also be inclined to explain the mechanization gap as a scale issue. However, a comparison of Albania and Bulgaria, two higher income countries with large gender gaps in mechanization, helps put this argument to rest. The RIGA data indicate that the land-operating size gap between male- and female-headed farming households in Bulgaria is 2.7 hectares, whereas in Albania, it is nearly zero (0.09 hectares).

As with fertilizer, another possible explanation is that women use less mechanical power when markets are thin. However, if we take mechanization use in a country as a proxy for the thickness of markets for mechanized farm tools and equipment, the data do not support this argument because the gap does not decline in countries where a higher proportion of households use mechanization.

Thus, given the large financial outlays associated with mechanization, the most likely explanation for the pattern that we identify is capital constraints. However, we have no concrete evidence for this explanation.

Labor

Numerous studies document the lower intensity of labor use in women’s fields. For example, using data from one region of Ethiopia, Pender and Gebremedhin (2006) show

that female-headed households use significantly less labor per hectare than do male-headed households. Looking within the household, Udry et al. (1995) show that the lower use of labor in women's fields in Burkina Faso is part of the explanation for the lower yields of these fields.

Women seem to have less access to household labor as a result of institutional constraints in the form of norms. One example of this phenomenon comes from Whitehead (1996), who explains that in North-East Ghana, women only receive access to the labor of household members below them in the age or gender hierarchy. Only senior women or those in large households have considerable access to labor. However, women in this area do not cite this situation as a constraint; rather, they cite a lack of cash needed to hire labor, to finance communal labor parties, and to purchase modern inputs.

Women's access to some forms of the labor market may also be constrained. Hill and Vigneri (2009) find that in Ghana, female cocoa farmers cannot obtain male labor through exchange labor groups because men and women are in separate groups. However, women need male labor for strength-demanding tasks, such as tree felling. Consequently, female cocoa farmers who have no other means of procuring male labor must rely on wage or annual labor.

Overall, labor constraints are likely to shape the crops women grow and the yields they obtain from these crops. For example, Von Braun and Webb (1989) argue that women have less access to labor-saving technology, such as oxen, and this helps to explain why women are more sensitive to labor requirements. In Malawi, Chipande (1987) finds that in a sample of 160 households, no female-headed households (16 percent of the sample) grew

tobacco and two grew improved maize although the Lilongwe Land Development Programme offered free inputs, such as seeds and fertilizer, on credit as well as extension. Chipande argues that female-headed households cultivated smaller plots and had less labor, which meant that they could not easily repay (and therefore did not apply for) credit. Women did grow groundnuts, which are more labor intensive than maize, but the labor requirement for groundnuts is spread relatively evenly over the year, and there are no sharp peaks in labor intensity. For Tanzania, Tibaijuka (1994) simulates reductions in women's time burdens and finds that this reduction has the potential to increase labor productivity by 15 percent and capital productivity by 44 percent and to increase farm cash incomes by up to 10 percent.

Human Capital

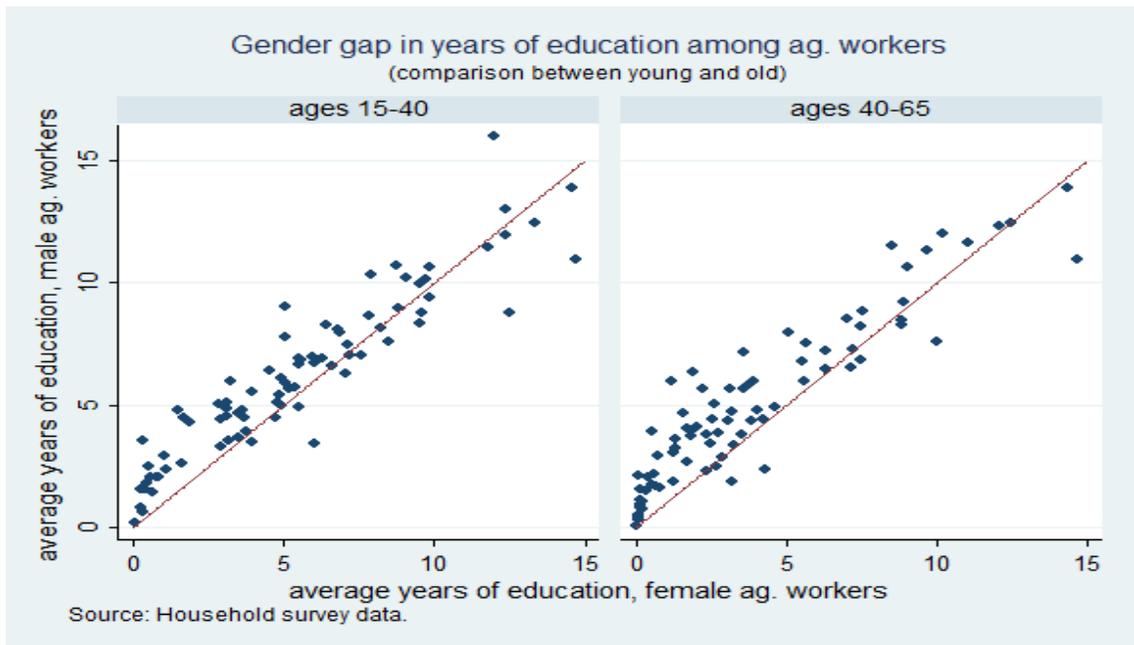
Some estimates of male and female differences in productivity show that education is significant. Moock (1976) shows that in Kenya, returns to education in terms of agricultural output are greater for female-headed households than for male-headed households. Alene et al.'s (2008) study of Kenya shows that after controlling for access to land and education, the yield gap between male and female maize farmers disappears.

Education affects agricultural productivity through a number of channels in addition to basic skills. First, education is important for the adoption of improved technology. Evidence from Kenya shows much lower adoption rates of improved seeds and fertilizers for female-headed households than for male-headed households. These differences are explained in part by lower education levels (Kumar, 1994; Saito, Mekonnen and Spurling, 1994). Second, education, especially at lower levels, may be important for obtaining access to credit. Using

data from Kenya, Saito, Mekonnen, and Spurling (1994, p. 88) show that education is a significant determinant in female farmers' access to formal credit, whereas it was not a significant determinant for men.

Given that the existing educational *stock* is tilted toward men, particularly among those of farming age, education is an important factor. However, the market or institutional constraints on this factor have largely been addressed (although it should be noted that a significant fraction of the areas—both countries and within countries—in which there a sizable education gap remains are predominantly agrarian). Figure 10 shows how this situation is changing. The right panel shows that among older agricultural workers (40–65 years old), men are significantly more educated than women are. Among the young (15–40 years old), this pattern is much less pronounced; many more countries fall close to the 45-degree line that signifies educational equality between men and women.

Figure 10



Unfortunately, Sub-Saharan Africa, the region with the lowest agricultural productivity, is the one region in the world where this gap does not appear to be closing.

Beyond general educational attainment, higher education for women in agricultural science and technology is particularly important in regions where women constitute a large part of the agricultural sector. The number of women working in science and technology research in industrialized and developing countries has increased substantially in recent decades, but this number remains low in most countries. Women scientists, research managers, lecturers, and professors can provide different insights and perspectives and can help research agencies to better address the unique and pressing challenges faced by African farmers. They may also serve as role models for students and for other women in agriculture. Progress has been made in increasing the share of female professional staff in agricultural higher education and research institutions in Africa (see the discussion on extension below), but the gap persists.

Technology—Improved Varieties

The evidence on gender and the adoption of improved varieties is mixed. For example, Doss and Morris (2001) find that in Ghana, female-headed households¹⁴ are less likely to adopt high-yield maize, but women in male-headed households are not. Bourdillion et al. (2003) use data from Zimbabwe (2003) and find no significant difference between male- and female-headed households in the adoption of improved seed. Gilbert, Sakala, and Benson (2002) document an extension and new technology trial in Malawi. Although this study has selection issues (extension agents disproportionately chose male-headed households), they find that among participating female-headed households, maize plots

generate lower yields, but when fertilizer and other inputs are provided, there is no difference across genders. In contrast, one study (Tiruneh et al., 2001) finds that in Ethiopia, female-headed households are less likely to adopt improved varieties (in this case, wheat). Additionally, a number of studies in Kenya and Zambia document the lower adoption of improved maize among female-headed households (Kumar, 1994; Saito, Mekonnen, and Spurling, 1994; Ouma, De Groote, and Owuor, 2006).

In cases in which there is lower female adoption of improved varieties, the main factors seem to be overall production constraints rather than norms with respect to women's use of new technologies. A number of studies in Kenya¹⁵ argue that women's lower adoption of technology is due to lower access to land, labor, and credit and lower levels of education, which are related to market failures in these areas. A solution may be to provide a more complete package of support. For example, the study by Gilbert, Sakala, and Benson (2002) shows that providing technology together with inputs and extension seems effective.

Technology—Extension and Other Agricultural Information Outreach¹⁶

In terms of cross-country data, the 1988–89 FAO survey of 97 countries found that 5 percent of extension resources were devoted to women, and only 15 percent of extension personnel were female (FAO, 1993). The fact that these are the most recent comprehensive data provides some evidence regarding the small amount of attention this subject receives.

However, the situation has likely improved since that survey. In terms of access to extension, recent figures come from a set of 2010 World Bank and IFPRI surveys in three countries. These surveys found that in Ethiopia, 20 percent of women compared with 27 percent of men had been visited by an extension agent. In Ghana, the figure was much

lower: 12 percent of male-headed households had received extension visits, whereas 2 percent of female-headed households had received extension visits in one region, and zero percent had received extension visits in two other regions. Indeed, even in male-headed households, only 2 percent of spouses received an extension visit. This finding is particularly striking in light of the fact that of the three countries, Ghana had the highest share of female extension officers. In Karnataka, India, 29 percent of land-holding male-headed households received an extension visit, whereas 18 percent of female-headed households did. For livestock extension, 79 percent of female-headed households had contact with an extension agent, compared with 72 percent for male-headed households (World Bank and IFPRI 2010, pp xxviii-xxix).

What seems to be the reason for this differential access? One factor is the bias of service delivery toward men, which stems from the belief that men are the decision makers and women are marginal farmers, if they farm at all (see, for example, World Bank and IFPRI, 2010). Related to this belief is the perception that when men are educated, knowledge will be shared with other members of the household (Meinzen-Dick et al., 2010). This assumption may be unrealistic, particularly when men and women perform different tasks or even grow different crops.

Of course, this bias may be due to the discriminatory norms of the institution. Systematic evidence of this discrimination does not exist, but individual cases indicate that this may be an issue. For example, in 2011, the U.S. government settled a class action lawsuit brought by women farmers alleging systematic discrimination by the U.S. Department of Agriculture. A second factor, which echoes the theme of interlinked

constraints, is the fact that many extension resources tend to be allocated toward larger, commercially oriented farms, where women are underrepresented for the reasons discussed above (and below). Third, constraints in other realms may hamper women's access to extension. For example, time constraints may limit women's participation in courses offered at agricultural extension centers, and their lower levels of education (for women educated before the gender gaps closed) may limit their participation when training by extension officers requires literacy or numeracy. Finally, social norms that prevent women's mobility (such as going to ask the extension officer for advice) or prevent women from speaking with a male without her husband present also constrain women's access to extension services.

Policy responses must take into account the cultural, time, education, and mobility constraints faced by women. In some locations, hiring female extension agents may be effective. However, there is evidence from some countries that women do not have difficulties interacting with male extension agents. Indeed, a study by Due, Magayane, and Temu (1997) in Tanzania showed that 26 percent of women farmers preferred a male extension agent, 40 percent preferred a female, and 34 percent were neutral. Men, in contrast, did not always prefer male extension agents; although 35 percent said they preferred a male, 30 percent preferred a female, and 35 percent were neutral (in a predominantly Muslim area). However, even when women farmers are allowed to interact with men and are comfortable doing so, extension agencies and agents must be made aware of the issues and constraints that women face. For example, the Government of Ethiopia has attempted to make its extension services more gender responsive by mandating its national and regional Bureaus of Agriculture to introduce extension services

that are closely linked to women's activities, to encourage women to participate in all programs, and to assist women in obtaining better access to agricultural inputs (Buchy and Basaznew, 2005).

In terms of other modes of delivery of agricultural information, a recent IFPRI evaluation of farmer field schools in East Africa showed enormous effects on agricultural productivity and income for female-headed compared with male-headed households in a matched difference-in-difference evaluation of three countries (Davis et al., 2009). However, Quisumbing and Pandolfelli (2010) and Meinzen-Dick et al. (2010) find that extension visits are likely to remain the main mode of transmitting technology and information to farmers. Extension information and training material must be adapted to women, who may have lower levels of education. Extension officers must also consider that women may not be able to travel beyond the village and that time constraints are often binding. Modern information and communication technologies, such as cell phones (which have seen significantly expanded use in developing countries) and radios, may also help in overcoming some of these constraints.¹⁷

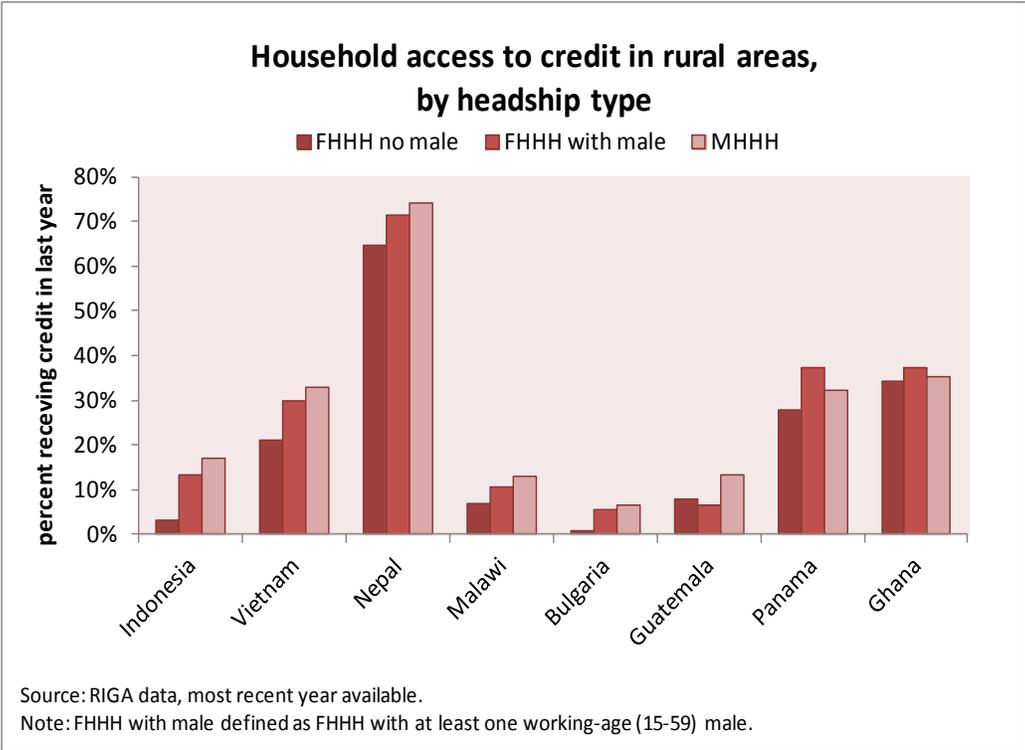
When women find it difficult to join male-dominated networks, women's groups can play an important role in providing women with access to important services, such as extension. Women's groups and other forms of collective action can be an effective means of building social capital and addressing gender gaps in other areas as well by reducing transaction costs, pooling risks, developing skills, and building confidence. At the national level, Meinzen-Dick et al. (2010) find that the capacity to provide services to women and to

focus on gender-specific outcomes as well as responsiveness to women farmers’ demands are essential to building strong programs that reach women farmers.

Credit

Female-headed households are significantly less likely than are male-headed households to use credit in a majority of the countries for which we have data (figure 11).

Figure 11



In six of eight countries, the gap between male- and female-headed households is significant (not indicated in the figure) when there is no male present. When a male is present, however, the gap (which is then much smaller) is only significantly different in three of eight countries. One significant counterpoint to this pattern (and others) comes from China, where de Brauw et al. (2008) find that female-headed households have equal credit utilization as male-headed households, and they have equal access to land and labor.

Unequal access to credit may affect economic efficiency. Fletschner (2008) finds that in rural Paraguay, households in which men have inadequate access to credit are 25 percent less economically efficient (i.e., loss in household revenue). In households of married couples, a wife's inability to meet her need for capital result in an additional 11 percent drop in economic efficiency. This result suggests the effect of credit constraints as well as intra-household issues; these households are clearly not pooling resources.

What is the reason for women's lower access to credit? For credit that requires collateral, women are disadvantaged relative to men because they have less land to place as collateral. Other potential issues include issues of education (for older women), mobility constraints, and different social networks (which may be important for accessing the appropriate person within a bank, for example). Moreover, in cases where credit comes from nonbanking institutions, norms may play a key role in restricting female access.

Interventions, particularly in terms of credit geared toward land, have shown little success in reaching women. For example, Deere and León (2003) cite the example of the FEPP (Fondo Ecuatoriano Populorum Progresso) in rural Ecuador, in which only 14 percent of the beneficiaries were female, and another program run by the Penny Foundation in Guatemala, in which only 1 percent of the beneficiaries were female.

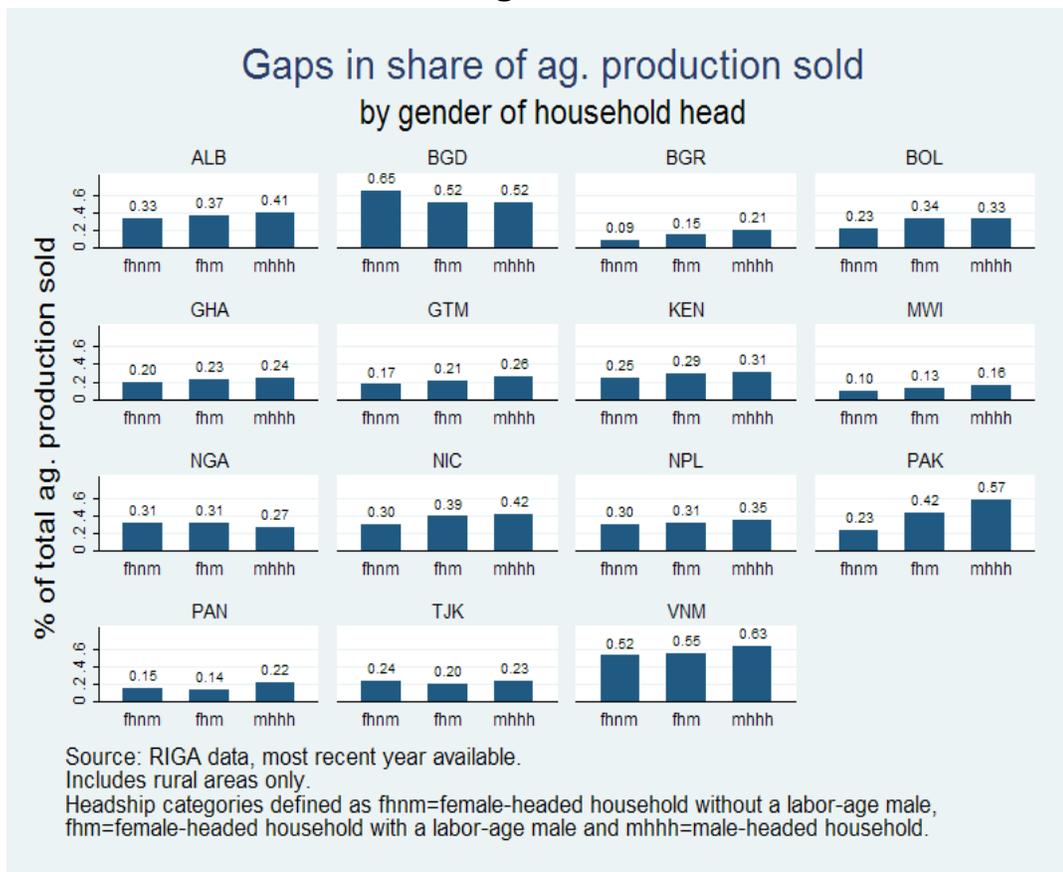
Export Agriculture: A Gender Low Productivity Trap and Some Ways Out

Most of the discussion on productivity (particularly the discussion of productivity differentials in section 2) refers to men and women who farm the same crop. The constraints discussed in section 3 also drive the choice of crop. In particular, these constraints (and others) tend to prevent women from engaging in more profitable

commercial or export crops. However, in relation to export crops and their processing, there may be some pathways out of this agricultural segregation.

Overall, women sell less of their output in the market, as shown in figure 12. With the exception of Bangladesh and Nigeria, in every country for which we have data, female-headed households sell a smaller percentage of their output, on average, than do male-headed households.

Figure 12



For commercial agriculture, a particularly important fraction (that is growing in many countries) is nontraditional (fruit, horticulture, and flowers) agricultural exports. The evidence points to a much starker exclusion of women than that shown in figure 11. For

example, Maertens and Swinnen (2009) find that only one out of 59 farmers in their sample of French bean farmers (export crop) in Senegal is a woman. Dolan (2001) reports that over 90 of export contracts in Meru, Kenya were issued to male household members. Porter and Philips-Howard (1997) report that in the smallholder sugar authority scheme in Malawi, only one participant was a woman (Nankumba and Kalua, 1989). In Kenya, the Kenya Tea Development Agency issues tea licenses to male household heads (von Bulow and Sørensen, 1993).

Evidence from Latin America shows similar patterns. For example, Raynolds (2002) finds that in the Dominican Republic, fruit and vegetable sector contracts are signed with married men (processing firm managers report that they typically refuse to sign contracts with single men), and women provide the labor. In the Central Highlands of Guatemala, 3 percent of contracts for snow peas and broccoli (two of the most important crops grown for export in the Central Highlands) are held by women (Katz, 1995).

This pattern seems to be explained by two reasons. The first is that when contracts are produced for export crops, they tend to be signed with men even though women often provide a significant fraction of the labor. For example, in South Africa, Porter and Philips-Howard (1997) find that 70 percent of sugar contracts are held by men, but 60–70 percent of the principal farmers are women. For a large contract farming scheme in China, Eaton and Shepherd (2001) find that women perform the bulk of the work but are excluded from signing contracts. Maertens and Swinnen (2009) find that contracts tend to be signed with men because companies prefer men because of women's limited access to productive resources; women lack statutory rights over land and have less authority over the family.

With regard to French bean cultivation, women lack claims to irrigation water and infrastructure, which are crucial for French bean cultivation in that region of Senegal. Thus, women's weaker rights over land, labor, and other resources lead exporting companies to sign contracts with men.

This fear on the part of the purchasers seems to be justified on a fundamental level. A number of studies indicate that as export markets evolve, women lose control of the export crop (and possibly the associated land) to men. For example, Ellis et al. (2007) find that although the farming of spices in Zanzibar has traditionally been a female domain, it is being taken over by men, with women providing the labor. In Malawi, Due and Gladwin (1991) find that with the increase in the profitability of hybrid maize, a cash crop grown by men, the land devoted to groundnuts, women's cash crop, was drastically reduced.

The second reason centers on the fact that female farming operations tend to be smaller and less well capitalized (see also the constraints discussed in section 3).¹⁸ For example, Porter and Philips-Howard (1997) examine a barley out-grower scheme in northern Nigeria and argue that irrigation farming is less feasible for women (because of the cost of pumps and the high labor requirement demand, which requires funding). Land is also a factor; Fafchamps (1992, 2003) argues that households with smaller plots are less likely to engage in cash crop production, and as indicated above, women are likely to have smaller plots. One interesting counterpoint to this argument comes from Hamilton, Asturias de Barrios, and Sullivan (2002), who conclude for the Central Highlands of Guatemala that larger operators have not forced smaller ones out of the market for export production. However, when women enter cash crop production, their smaller plot size incurs higher

fixed marketing costs, which may affect their choice of market outlet. Hill and Vigneri (2009) also note the link between land ownership and credit.

New opportunities can also lead to change. For women cocoa farmers in southern Cameroon (Kumase, Bisseleua, and Klasen, 2010) and western Ghana (Quisumbing Payongayong, and Otsuka, 2004), the individualization of land ownership has strengthened their land rights. Many husbands circumvent traditional practices by allowing their wives to inherit land through indirect means, which are often explained as rewards to wives for helping their husbands plant and cultivate cocoa, a labor-intensive traditional export crop. In Ghana, cocoa has been expanding, and the increased demand for labor has given women greater bargaining strength.

Thus, on the production side, we can see signs of a gender-differentiated low productivity trap in most cases: the lower resources (and rights) of women lead to lower access to export or commercial agriculture, which, in turn, prevents women from accumulating resources. However, the labor used for the processing of nontraditional agricultural exports offers a more optimistic assessment. In nearly all cases, nontraditional agricultural export production is relatively labor intensive, and women provide a considerable amount of the labor (see, for example, Deere 2005 and Maertens and Swinnen 2009). Women typically earn minimum wage in the nontraditional agricultural export packing industry, but that wage is generally more than they can earn elsewhere (Deere, 2005; Meier, 1999). The wage gap is often found to be lower or absent (Deere, 2005; Friedmann-Sánchez, 2006), and piece-rate wages are often the same. Dolan and Sutherland (2002) observe that although wages are the same, men and women rarely do the same

work; women are more concentrated in the unskilled jobs. Maertens and Swinnen (2009) argue that women gain from contract farming mainly through wage labor. For example, in the Niayes area of Senegal, wages earned in the French bean export industry constitute one-third of household income for households involved in this industry, and 85 percent of those wages were earned by women. In the Senegal River Delta, 45 percent of the income derived in the tomato industry is earned by women. Although these incomes represent a major source of revenue for these households, most studies indicate that women's opportunities for advancement within the export processing industries (e.g., promotion to management) are relatively limited.

Conclusion

The studies described above indicate that female farmers in many countries have lower yields than do male farmers. This gap has not resulted because women are worse farmers than men but rather because their use of key inputs and services and their control over resources is limited. Moreover, this shortfall in use (whether it is due to lower demand or lack of access) and limited control over resources may be reasons for agricultural segregation, the concentration of women in lower-value, less-marketed crops. The evidence presented in this article indicates that, overall, these gaps do not seem to systematically improve with economic growth, household wealth, or overall use of an input or resource in the country.¹⁹

The evidence is not conclusive or comprehensive, but the factors that contribute to this position of disadvantage seem to stem from a range of institutional, social, and market factors. For example, women's weaker land tenure can be traced to their lack of voice

within the institutions that govern property rights. These patterns also point to a clear need for further research to understand the causes in areas in which there are multiple explanations (for example, fertilizer) or where very little is known (for example, labor). Moreover, there are complementary factors and inputs for agricultural productivity that we have not covered here because the evidence does not permit even a speculative argument. Examples of these include gender differences in access to common property resources and related issues of natural resource management (see, for example, Quisumbing and Pandolfelli, 2010; Zwarteveen and Meinzen-Dick, 2001) as well as potential gender differences in approaches to risk. These are critical areas for further investigation.

The policy response must understand the roots of these problems and address causes at the roots rather than merely addressing symptoms. Further research using tools such as rigorous impact evaluations can help to explain which policy tools can effectively address these constraints. In addition, by considering total farm productivity as well as the use of any given input, this research can help to identify which constraints are the most binding. For example, an evaluation of agricultural credit could yield insights into whether relaxing this constraint would help to relax constraints in the areas of land, fertilizer, and labor and whether this approach could be complemented by inferential research that identifies important issues and how to address them. Moreover, some of the research discussed above suggests that addressing multiple constraints simultaneously (for example, providing appropriate extension for high-yield varieties as well as ways to access the needed inputs) is likely to be more successful than addressing single constraints. This is another fruitful avenue for further research, perhaps in direct comparison to research on the effects of addressing key binding constraints in one area. In addition, the use of panel

data, if or when such data become available, would benefit future research efforts. Ultimately, given that at least some of the yield differences between men and women stem from inefficiencies, the economic payoff of addressing them is likely to be significant.

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¹ Productivity is often measured by using partial indicators, such as yield. However, productivity also refers to output in relation to total input use. To clarify the discussion, we will use the term "production

efficiency” when referring to the productivity of all inputs used. For more examples of gender productivity differentials as well as a discussion of the methodological issues, see Quisumbing (1996) and FAO (2011).

² A study by Jamison and Lau (1982) finds that among mechanized farms, farms of female-headed households have lower production efficiency than those headed by males, even when all inputs are considered. Unfortunately, their study does not offer a definitive explanation for this difference.

³ A few studies that are not from Sub-Saharan Africa focus on labor productivity. Rahman (2010) finds no differences between male and female labor productivity on Bangladesh farms when input use is the same. Aly and Shields (2010) find that labor productivity for rice in Nepal is the same when irrigation and seed type are considered.

⁴ Allocative efficiency refers to a farmer’s ability to allocate resources in such a way as to maximize profits. Production efficiency is a measure of whether a farmer (or group of farmers) achieves the maximum output possible with the given inputs. The maximum possible output is defined by the production technology and the sample of farmers included (i.e., it is not some hypothetically possible maximum). When the analysis is based on groups (by including a dummy), then the measure concerns the relative efficiency of one group versus the other.

⁵ Adesina and Djato (1997) tests for the relative profit efficiency of women versus men farmers (first proposed by Yotopoulos and Lau, 1973). They do this by including a gender dummy in their regression analysis, thereby allowing for different intercepts for the two groups. If the intercept of one group is higher (and this difference is statistically significant), then that group is relatively more profit efficient (than the other group). Goldstein and Udry (2008) follow a similar approach, but they look at within household production. When this dummy is significant, it is indicative of profit inefficiency within the household.

⁶ New work being undertaken in the Living Standards Measurement Study–Integrated Surveys for Agriculture (LSMS-ISA) in a number of African countries will provide further insight into this assumption because these surveys provide more in-depth measurements of the different roles within farming households (e.g., understanding who manages versus who owns an individual parcel).

⁷ RIGA is an FAO project that has created an internationally comparable database of rural household income sources from existing household living standard surveys for more than 27 countries (www.fao.org/economic/riga/en). We use RIGA because it is a collection of some of the most recent household surveys in which a host of variables relevant to farm households, such as farm mechanization, have been prepared across surveys (when available) in a manner that makes them directly comparable. Data are presented for all countries for which the relevant variable was available in the RIGA database at the time of the analysis. The three-letter country codes (year of survey in parentheses) are ALB for Albania (2005), BGD for Bangladesh (2000), BOL for Bolivia (2005), BGR for Bulgaria (2001), GHA for Ghana (1998), GTM for Guatemala (2000), IDN for Indonesia (2000), KEN for Kenya (2005), MWI for Malawi (2004), NPL for Nepal (2003), NIC for Nicaragua (2001), NGA for Nigeria (2004), PAK for Pakistan (2001), PAN for Panama (2003), TJK for Tajikistan (2003) and VNM for Vietnam (2002).

⁸ The most comprehensive data on women’s access to land come from the FAO Gender and Land Rights Database (www.fao.org/gender/landrights). These data show that there are stark gender differences in land holdings across regions (FAO 2011).

⁹ Other work shows that in absolute terms, female-headed households have lower land ownership. For example, Deere and León (2003) use a range of farm surveys from Latin America to show that female-headed households, on average, have less land than do male-headed households, although this difference is only significant in two of the nine countries for which they have data.

¹⁰ For Indonesia, we note that land operating statistics are calculated only for households that operate land, and female-headed households tend to operate land much less frequently (36 percent of female-headed households operate land versus 58 percent of male-headed households). Therefore, large observations have a greater influence on the female-headed household mean. We find that female-headed households, on average, operate 8.4 hectares of land versus 6.1 hectares for male-headed households. Furthermore, we note that female-headed household with (at least one) male present operate 9.3 hectares on average, and female-headed household without males operate 5.8 hectares, on average, lower than the male-headed household average of 6.1 hectares.

¹¹ See, for example, World Bank, FAO & IFAD, 2009, Module 12, Thematic Note 1, and Actionaid, 2010.

¹² Deere and León (2003), p. 933.

¹³ Mechanization is defined in the RIGA as the use of an input that uses a motor of some form.

¹⁴ Defined here as unmarried women because the survey did not explicitly ask the gender of the household head.

¹⁵ Reduced availability of land and labor to female-headed households (Kumar, 1994), lower education levels of female-headed households (Saito, Mekonnen, and Spurling, 1994), and more limited access to credit markets (Ouma, De Groot, and Owuor, 2006).

¹⁶ Although extension overlaps with technology adoption, we consider it separately here because extension is often the avenue for information to improve the production efficiency of existing crops.

¹⁷ See Quisumbing and Pandolfelli (2010) for additional information on promising approaches to help female farmers.

¹⁸ Mobility (and hence the ability to actually get to markets) may also play a role here, but the evidence for this is quite vague.

¹⁹ On the basis of the RIGA data (not presented in the paper), we found that, with the exception of land owned (where there is a diversity of relationships found), the gap seems to widen with household wealth.