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Female Land Rights, Crop Specialization, and Productivity in Paraguayan Agriculture

by

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ABSTRACT

Previous work has shown a pattern of lower household incomes for those Paraguayan farms with female landowners in the household. The study of agricultural production reveals that Paraguayan women specialize in livestock and dairy production, while men specialize in crop production. An analysis of crop specialization and crop yields finds no significant differences in yields among households along gender lines, although women appear to specialize in food crops. Finally, households with female land rights have markedly lower rates of return on agricultural production.

Keywords: Gender, Economic Development, Land Rights, Farm Income

JEL Classifications: D13, Q15, O54

1. INTRODUCTION

This article is an assessment of the impact of women's land rights on agricultural productivity in rural Paraguay. This study takes a step beyond the comparative work done by Carmen Diana Deere, Rosa Luz Durán, Merrilee Mardon, and myself on Brazil, Peru, and Paraguay (Deere et al., 2005). In that report, we found that households with female land rights had higher net nonagricultural incomes, but lower net agricultural and net household incomes. This article, then, is an attempt to explain lower agricultural incomes in households with female land rights. I will do this by investigating differences in crop yields, crop specialization, and farm activity specialization by owner-operated rural farms with and without female land rights.

As Agarwal (1994), and Deere and León (2001) have argued, land rights for women are key determinants in women's and household welfare in rural settings throughout the developing world. Agarwal, studying the issue in South Asia, defines women's land rights as comprising ownership of and independent control over land. She puts forth four main arguments for women's land rights. First, that women's land rights lead to improved welfare for women and for children. This is due to the systematic bias towards men in intrahousehold resource allocation, the fact that resources under women's control are used more towards household (especially children's) needs than those under men's control, and the increasing portion of households headed by women alone. Since land is such an important economic resource, women's land rights will improve welfare. Second, women's land rights lead to increased productivity. This increase comes about because titled land is useful as a means of securing credit and other inputs, and provides a greater incentive to make efficiency-enhancing improvements. So ownership with secure title will increase the efficiency of female farmers. It may also increase overall efficiency, due to the indirect effects of the first point (better overall household welfare may increase productivity). Third, women's land rights increase equality for women relative to men in the household and the community. And fourth, women's land rights empower women by giving them an economic base from which to challenge gender oppression in the household and society at large.

While Agarwal addresses these issues in the context of South Asia, Deere and León's focus is on Latin America, tracing the effects of the women's movement and neoliberal policies on women's land rights. They expand Agarwal's four main points in the Latin American case.

Their research reveals that, while substantial progress has been made towards de jure gender equality, de facto gender equality with respect to the distribution of property remains elusive. Many countries in the region have instituted legal reforms that have strengthened married women's land rights. However, the actual mechanisms for distributing land have not changed sufficiently and, as a result, the distribution of assets, especially land, in the region as a whole remains largely skewed towards men. While Agarwal makes the case that independent title to land is crucial for the South Asian case, Deere and León (2001) argue that, currently in Latin America, joint titling will be the most effective means of increasing women's land rights. This is due to a combination of factors unique to current land reform efforts in the Latin American context. First, since family farming predominates, land tends to be distributed to household heads, usually men. Second, rather than distributing land, governments are titling land as the means of creating a well-functioning land market in order to foment economic growth and efficiency in the agricultural sector. In this institutional context, joint titling is currently the most reliable means to ensure that women as well as men enjoy rights to land.

Thus far, little empirical work has been done on the impact of women's land rights on outcomes in rural Latin America. A growing body of studies elsewhere (especially in Africa) has focused on the effects of women's land rights on agricultural production and women's welfare in rural areas. Some of the themes uniting this literature are the attempt to model and measure household agricultural production, the examination of the effects of societal gender discrimination on female-headed rural households, and the effects of gender discrimination within rural households on agricultural production. This study builds upon the study of gender and land rights in Paraguay, Peru, and Brazil undertaken by Deere, Durán, Mardon, and myself for the World Bank (Deere et al. 2005). We found that in Peru, net household and nonfarm income were significantly[1] higher, and net farm income was lower in households with female land rights. In Paraguay, while households with female land rights also had significantly higher net nonfarm incomes, they had lower net household incomes and significantly lower net farm incomes. Is this evidence that Agarwal's assessment of female land rights is in error? Not necessarily. Our measure of female land rights is really a measure of female land ownership. In the Paraguayan Living Standards Measurement Survey (LSMS) data set, no information is

[1] A clarification: From this point forward, significant will mean statistically significant at least at the 10% confidence level both for testing of differences of means among categories and for testing of coefficients in regression estimations.

available about direct control over land. Since this is only one part of Agarwal's definition of effective rights, these results may in fact support Agarwal's point that control over land, as opposed to simple ownership, is vital.

In Paraguay, women have land rights in only 12% of rural owner-operated farms (Table 1). Even those households with female land rights are at a disadvantage compared to the rest of households. The average household with female land rights owns just over six hectares, compared to the overall average of more than thirteen and a half hectares, while they operate less than half of the land of the average farm. In addition, the average household with female land rights generates one-half of the overall average net farm income (Table 2). Those farms generate a little over half the average net farm income per capita, but in terms of net farm income per hectare, farms with female land rights generate 162% of the overall average.

Why do Paraguayan farms with female land rights have lower farm incomes? One possible explanation is that households with female land rights have less land, and so, less earning potential. While this is an accurate assessment of the position of households with female land rights in Paraguay, the regression analysis in the World Bank report controlled for the amount of both land and other assets by households, implying that the amount of land is not the only issue. Another possible explanation is that households with female land rights are less productive, the opposite of what Agarwal claims. This possibility seems unlikely, at least at first glance, given the higher land productivity for households with female land rights reported in Table 2. A third explanation is that households with female land rights use land differently, either in terms of the mix of farm production (agriculture versus animal husbandry), in terms of crop mix, in terms of the objective of production (food versus cash), or a combination of some or all of these differences.

This article explores these possibilities by relating crop specialization, crop yields, and productivity to measures of women's rights to land. I test the hypothesis that productivity differences cannot account for lower farm incomes for households with women's land rights. In order to do this, I look for gendered cropping patterns and related efficiency differences. I also examine the impact of women's land rights on both crop yields and general agricultural productivity. If households with female land rights have higher yields or productivity, or if there is no significant difference between households with and without female land rights, this rules out the productivity explanation of lower farm income, at least in the case of Paraguay. Finding

that households with female land rights have higher yields or productivity would lend empirical support to Agarwal's second point. This article adds to the emerging picture we have of asset ownership's impact on women in the less-developed countries.

2. LITERATURE REVIEW

The literature on the intersection of gender and agricultural productivity is large and growing. I attempt to summarize its main points as they apply to the subject at hand. First, I consider those studies relating to the impact of gender relations on the availability of inputs (including assets and assistance) to agricultural households. Second, I review those works that attempt to model and/or quantify the effects of gender on the agricultural household production process and on agricultural output. Third, I briefly discuss two crucial methodological aspects of assessing the effect of women's land rights on agricultural productivity: measuring women's land rights and measuring productivity.

There is a wide body of literature focusing on the impacts of gender discrimination on women's access to resources in general and to inputs into agricultural production. The most important resource is land, of course, but other notable examples are education, credit, and technical assistance. Women's ability to obtain agricultural inputs is also directly constrained by gender discrimination, but the indirect effect that differential access to resources (especially credit) has on women's ability to obtain inputs for production may be equally, if not more, important.

Women are much less likely to own land in much of the world. Latin America is no exception. Studies tell us that in Brazil, Mexico, Nicaragua, and Peru (Deere and León 2003), as well as El Salvador (Lastarría-Cornhiel 1988), women are in the minority of landowners. In the sample for this article, 12% of households had women landowners (see Table 1). Deere and León (2003) study the sources and incidence of land ownership by women throughout Latin America. They find that men are more likely to acquire land through markets. Due to gender bias in land markets (and imperfect markets for credit and labor), women are less competitive in the land market. Thus, women are more likely to inherit their land than buy it. Though the institutional situation of women is improving both within and outside of marriage throughout Latin America, land is increasingly concentrated and the land market is increasingly important in gaining access

to land, so a wait-and-see attitude towards women's land rights is inadequate to address the unequal distribution of land. "Human capital" also seems to be unequally distributed between men and women. There has been a pattern of women receiving less education (Moock 1976) and extension services may be biased towards men (Moock 1976; Doss 2001). Indeed, the types of technologies developed may be biased towards male tasks (Doss 2001).

Agarwal (1994), and Deere and León (2001) define effective women's land rights as requiring legal ownership of land by women, societal recognition of that ownership, and effective control by women over land that they own. This definition is comprehensive and reflects an awareness of the many nuances of present-day gender relations throughout the world. As such, this definition of women's land rights imposes strong information requirements on those who wish to employ a meaningful measure of women's and rights in an empirical investigation.

Unfortunately, data collection has yet to completely catch up with these requirements and studies to date have needed to use less satisfactory measures to assess the impacts of gender. Quisumbing (1996) critiques the methodology of studies of gender differences in productivity and reviews their findings. Most studies of gender and productivity use female household headship as an explanatory variable (Lastarría-Cornhiel 1988; Jacoby 1992). But this focus on headship has several problems. First, it obscures the real issues—who has ownership of the land and who has actual decision-making power in the production process (not necessarily the household head in either case). Second, female household headship is endogenous, a product of the marriage market and marriage dissolution (Quisumbing 1996). The best information to have would be detailed plot-level information about ownership and decision making in agricultural households. Without this information, we are left to make inferences about farm management, for example, using the amount of time spent in farming activities as an indicator of individuals' decision-making influence (Deere et al. 2005).

Moving to the literature on gender effects on agricultural production, we can identify two main themes. The first focuses on the effects of gender on the allocation of resources among household members. The second examines differences between men and women farmers. I review each theme in turn.

Departing from the relatively old-fashioned, unitary model of the household (in which the household is modeled as though it were an individual maximizing its utility, leaving no room for

differential resource preferences and allocation) allows richer explanations of household behavior. Bargaining models attempt to reflect the resolution of conflicting priorities among members with differing power within households. Many of the early models assumed that the outcomes of these processes were Pareto efficient. However, there is ample evidence that outcomes do not achieve even Pareto efficiency. One of the more obvious examples is the incidence of violence among household members, usually aimed at relatively (usually physically) weaker members, often women and children. Also, empirical studies of farm household outcomes have yielded evidence of inefficient allocation of resources along gender lines, and to the detriment of women (Tibaijuka 1994; Udry et al. 1995; Udry 1996). Thus, more recent examinations of household behavior have focused on decisions about resource allocation. Some of these models attempt to determine how decisions are made, while others examine the effects of decisions on production.

Most of the empirical work on intrahousehold gender effects on production has been on Africa, since in that context, men and women commonly have their own plots to farm. In Latin America, where family farming is the predominant mode of farm organization, such studies are much harder to carry out. African cases studies have found evidence that resources are allocated inefficiently based on gender (Udry et al. 1995; Udry 1996). Others have quantified the costs in lost production due to gender-related misallocation of resources (Tibaijuka 1994). Thus, the standard models of household production (including cooperative bargaining models) that assume Pareto-efficient allocation of resources within households are not adequate for capturing the gender dynamics of resource allocation within households.

Studies addressing gender differences in production itself include attempts to measure both differences between men and women, and the costs of gender-related inefficiencies in agricultural production. Reviewing the results in the literature, Quisumbing (1996) notes that the literature itself is biased towards finding differences between men and women, since those studies finding differences are more likely to be submitted and published. Nevertheless, the studies she reviews find no significant differences in technical efficiency between male and female heads or managers, though there may be some evidence for differences in allocative efficiency. Attempts to quantify differences between men and women have employed various measures of farming ability. Land productivity, that is, total output (usually aggregated with prices) divided by size of farm, is one of the most frequently used measures (Lastarría-Cornhiel

1988). Labor productivity (Jacoby 1992) and crop yield (Moock 1976), frequently combined with an analysis of crop specialization (Moock 1976; Doss 2002), are two more oft-used measures. Moock found that women had higher yields of corn per hectare (what Moock calls technical efficiency) than men. Jacoby (1992) finds that women contribute more to livestock production and men contribute more to crop production. Doss (2002) concludes that in Ghana it is not possible to divide individual crops into men's and women's crops. However, she does find that gender-based cropping patterns exist, and so cautions that agricultural policy cannot be considered gender neutral. For example, female-headed households are more likely to be affected by staple crop policies than women in male-headed households.

A great deal of literature has been devoted to the measurement of agricultural productivity (see Binswanger, Deininger, and Feder 1995, for a full discussion). I limit my comments here to the additional insights that a focus on gender lends us. A problem with all of the studies reviewed by Quisumbing is that household work, which women are more likely to do, is not valued. If this work is productive, in the sense of creating marketable value (i.e., processing agricultural products), neglecting it implies bias against women in productivity measurements. More generally, all of the studies neglect the endogeneity of input choices, leading to biased coefficients (Quisumbing 1996). Unless we have detailed data on household work performed and a consistent way to assign value to it, problems arise for our analysis. First, any measure of total household production is biased downward. This bias may not be a problem if it is randomly distributed among households, however, it is likely that this bias will be larger for female-headed households. The second problem that arises is that the size of this bias will be inversely related to household size, since in smaller households, uncounted household production is a greater share of total household production to the extent that there are economies of scale in household production. Third, since women are likely to provide the majority of household production, women's contribution to total production is consistently underestimated. Fourth, to the extent that women's production is in areas that are less easily valued (such as food crop production), that labor is again likely to be undervalued, since staple crop returns will tend to be lower than cash crop returns. These problems, taken together, mean that the measurement of total agricultural household production is biased against female-headed and small (in terms of farm size) households.

To sum up, we can make several observations on the literature relating agricultural

productivity and gender. First, the question of how best to quantify gender itself is crucial. Detailed data on decision-making power at the plot level within agricultural households is needed to do so. Second, the production of women is likely to be understated, to the extent that women perform unpaid and uncounted household labor. In order to alleviate this problem, detailed information on all the household production activities of women and men is needed. Third, women are likely to have less access to a variety of resources, especially land, which constrains their ability to produce efficiently. Fourth, within households, women's productive activities are likely to be handicapped by resource allocation decisions that are biased towards male activities. In order to account for all of these phenomena and to address these issues, more and better information is required. While progress in data collection has been made, there is still far to go. Further work in this area is clearly needed, in Latin America and elsewhere. This article contributes an analysis of the impact of gender on crop specialization, crop yields, and productivity. While this is a step forward, previous work makes it clear that more cross-country studies are needed, since context is crucial in all of these issues (Deere et al. 2005).

3. DATA AND METHOD

The literature makes clear the need for good information on the inner workings of households. Unfortunately, it is still the case in Paraguay, as elsewhere, that the sort of detailed information needed to isolate the impacts of gender on production and welfare in rural households is largely lacking. I use the MECOVI Living Standards Measurement Survey, designed according to the World Bank standard for this type of survey, and conducted over the course of one year between September 2000 and August 2001, by the Ministerio de Agricultura y Ganadería. This is the first survey completed in Paraguay that has data on ownership of land by individuals. Thus, this is the first time we can assess the impact of women's land rights directly. The data set does have limitations, however. Data on individual ownership is available only at the household level. Plot-level data on ownership, which would be ideal, is not available. The survey includes relatively detailed information on economic activity by individual, but not on the crucial question of who makes the decisions. This means that I will not be able to assess the impact of female land rights in the full sense of the definition given by Agarwal—I have no way to determine independent control over land. Thus, this article, while a step ahead of many past attempts to link female land

rights with productivity, will suffer from many of the problems of interpretation of previous work in this vein.

What measure of productivity to use is certainly an open question. Most studies have used land productivity (aggregate output divided by farm size). But this measure is subject to criticism as giving too much importance to one input, land. Binswanger, Deninger, and Feder (1995) suggest the use of the following specification for testing the farm-size productivity relationship:

$$P/K = g(OP,OW,H,Z) \qquad (1)$$

where P is profits net of family labor costs, K is assets, OP is operational holdings, OW is owned land, H is the number of household workers, and Z is a vector of exogenous variables (such as land quality, etc.). However, the question of how to value family labor costs is left open. In this case, since there is little opportunity for alternative employment in the Paraguayan rural sector, I assume that the opportunity cost of family labor is negligible.

I measure women's land rights based on whether or not a female in the household has title to land.[2] Crop yields are measured using the total harvested value divided by cropped area for each crop. For productivity I use both land productivity (the net farm income divided by the operational area of the farm) and rate of return (the net farm income divided by the total value of farm assets).

Since I will not be using a production function approach, functional form is not an issue at present, as with many other studies (Quisumbing 1996). I use linear and log-linear models to estimate the relationship between the crop yield and productivity variables, and female land rights. I will also include as explanatory variables various household, farm, and regional characteristics. The household characteristics include: the sexes of single household heads, the age and education of the household head(s), household size, and the number of adult members. The farm characteristics I use as explanatory variables include the size of both ownership and operational holdings. The regional characteristics include the zone in which the farm is located

[2] This includes cases in which women alone own land, in which both women and men own land individually, or in which women own land jointly with men.

and an index of soil quality for the district in which each farm is located.[3]

4. FARM INCOME

First, consider the demographics of the gender variables among farm households in this survey.[4] Of the 1,837 rural owner-operated farm households in this survey, 76.9% were dual-headed, 14.5% were female-headed, and 8.6% were male headed (see Table 1).[5] Of these owner-operated farm households, households with male owners make up the largest number, 41.1% of the total. Female owners are in 10.6% of households, with joint ownership characterizing only 1.4% of households. Thus, only 221, or 12%, have some female land rights. Note that 861 households (46.8%) either did not have title to land or the titleholder was a nonmember, so nothing is known about the identity of the owner. Thus, while only 12% of households had some female land rights, 22.6% of households with known title-holders did. For each of the gender categories, women own and operate significantly less land and men own and operate more land. For the rest of this analysis, I use sex of household heads and female land rights.[6]

Previous work showed that in Paraguay, female land rights significantly reduced net farm income (Deere et al. 2005). I now examine net farm income, net farm income per hectare, and the shares of gross farm income from each of its four components (crop, cattle, dairy, and processed; see Table 2).[7] I use generalized linear regression to test for significant differences in

[3] This index is a weighted average of soil quality based on soil types found in each district, from information given to me by the Minsterio de Agricultrura y Ganadería (MAG).

[4] Due to the use of survey weights and rounding in generating tables and statistics, frequencies may not add up to the totals and percentages may not add to 100%.

[5] By dual-headed households, I simply mean those households in which a male and female pair of adults is present. In the survey, these household members are listed as Jefe/a and Esposo/a/compañero/a. I make no assumptions about which of the two is the "head" in the household. No households listed same-sex pairs of adult heads. Female headed and male-headed households are those in which only one person from these two categories is present.

[6] Earlier versions used the expanded ownership categories, but these did not add much explanatory power.

[7] Net farm income here means the total value of farm production valued at market prices (gross farm income) minus all the costs of production, including family labor, also valued at market prices. In 2000, the exchange rate for Guaranies (hereafter, simply G) averaged about 3,685 G per U.S. dollar, so one million G is roughly equivalent to $271 U.S. in 2000. Crop income includes the value of all crops harvested minus crops processed; cattle income includes all livestock sold or eaten plus livestock growth (assumed to be 10%); "dairy" income includes all milk, eggs, honey, and rawhide produced minus processed; and processed income includes total value of all starch, corn flour, marmalade, cane honey, soy milk, cotton thread, cheese, cold cuts, lumber, firewood, charcoal, wooden posts, and essence of Petit Grain produced minus the value of the crops and dairy products processed.

means by gender.[8] For this section's discussion, income is defined as net farm income, income per capita is defined as net farm income per household member, and income per hectare is defined as net farm income per hectare of land operated (farm size). While the average income for all households in the sample is 6.519 million G, the average income per hectare is 1.689 million G. Households received the largest part of their gross income, 38.53%, from crops, with dairy coming second at 33.58%, and cattle third at 20.48%. The revenue from processed goods was the smallest share at 7.41%.

Those households with female heads have significantly lower average income and dual-headed households have significantly higher average income than the sample average, with the average income for female-headed households being less than half the overall average. Female-headed households earn significantly less in terms of per capita income as well. Female-headed households get a significantly larger share of their gross income from dairy and a significantly smaller share from crops. Households with female land rights have significantly lower income and income per capita, but higher income per hectare. In addition, households with female land rights receive significantly more of their income from dairy production and significantly less from crops and processing.

So, while farms with female land rights do have lower incomes, they have higher income per hectare. This phenomenon is apparently explained by recalling the differences in land holdings among the various gender categories: households with female land rights, female management, and female household heads all own and operate significantly less land. The prior study controlled for the size of farm, which we found to increase income significantly (Deere et al. 2005), and still found lower agricultural income for households with female land rights. So while women's lack of access to land is a part of the explanation for lower incomes, it is not the whole story.

In summary, we can now identify gendered patterns to rural farm production in Paraguay. Households with female heads and female ownership receive less income and more income per hectare than other farms. These same households get more of their farm revenue from dairy

[8] For example, testing the difference of means of the net farm income by the household head, I run a generalized linear regression of the following model:

$$\text{net farm income} = \beta 1 \text{female\_head} + \beta 2 \text{male\_head}. \quad (2)$$

If $\beta 1$ or $\beta 2$ are significantly different from zero, I say that female-headed or male-headed households receive significantly different net farm incomes from dual-headed households, the default category.

production and less from crop production. Is there an economic rationale for these patterns? In order to further explore the impact of gender on farm households, I investigate differences in crop yields and gender crop specialization, before moving on to attempt to explain differences in income per hectare and in the rate of return based on Equation 1, above.

5. CROP SPECIALIZATION AND CROP YIELDS

What, if any, cropping differences are there between men and women? To investigate crop specialization, I examined cropping patterns by household head, female land rights, and female management. This is an attempt to identify "women's" and "men's" crops. I could then test those crop's yields on the gender variables to see if women have a productivity advantage in women's crops and vice versa. I first studied individual crops, ordering crops by the number of farms growing them and by the area sown to each. I then examined the incidence of each of these with the household headship and female land rights. However, no significant differences by gender appear at the level of individual crops among farms. By looking at the uses of each crop, I am able to distinguish between two categories of crops—cash crops and food crops. I define cash crops as those of which farmers sell more than half of their harvest.[9] In addition, 80% of the harvested weight of sugar cane goes to cattle feed, but that is what's left after processing the cane for sugar production, most of which is sold. Thus, I categorize sugar cane as a cash crop. Food crops are those crops of which farmers eat more than half of their harvest.[10] Almost all Chipá corn is processed into corn flour (used to make the delicious bread, also called Chipá). Farm households consume most of this flour, so I categorize Chipá as a food crop. Other crops were split among processing, cattle feed, cash, and consumption. In each of these cases, by dividing the portions going to the other uses into the proportions of each use that goes to consumption and sales in the end, I am able to classify these "mixed use" crops into cash crops[11] and food crops.[12] This accounts for almost all of the crop production in the country, whether measured by area

[9] These include cotton, soy, wheat, Tupí corn, tobacco, irrigated rice, onion, sunflower, mint, pumpkin, cantaloupe, watermelon, castor, peas, eggplant, snap beans, Lima beans (Poroto Manteca), sesame, tomato, peppers, carrots, cabbage, cucumber, beets, Swiss chard, celery, watercress, green onions, parsley, turnip, coffee, sour orange, pineapple, tung, Yerba Mate, papaya, and mandarin orange.
[10] These crops include peanuts, Lima beans (Poroto), potato, dry bean, unirrigated rice, garlic, strawberry, lettuce, radish, banana, grape, avocado, guava, lemon, sweet orange, and Shadduck.
[11] Squash, sorghum, other corn, and mango.

sown or harvested value.

I now examine the incidence of each type of crop, the area sown to each type, the harvested value of each type, and the value harvested per hectare (yield) for each type, all broken down by the gender variables. Here I use chi-square tests to check significance for incidence, and a generalized linear regression to test for significant differences in means.[13] Female-headed households and households with female land rights are both less likely than the sample population as a whole to sow both food and cash crops (Table 3). Female-headed households sow significantly less land to food and cash crops, while dual-headed households sow significantly more land to food crops. For food crops there are, however, no significant differences in the share of land sown over households with different kinds of heads. Finally, male-headed households sow significantly more land to cash crops and overall (remember that male headed households own and operate three times as much land as female-headed households). The same comparisons over the presence of female land rights yield significant results across the board: less land sown to food crops, cash crops, and all crops, and a smaller share of land to food crops and to cash crops.

In terms of harvested value and yields, the patterns repeat (Table 4). Female-headed households get significantly smaller harvests in value terms in both cash and food crops. Dual-headed households have significantly higher cash crop harvests. These results follow from the differences in farm size and area sown reported above. None of the differences in yields are significant, but female-headed and male-headed households' food crop yields were lower than cash crop yields, while for dual-headed households the opposite was true. Again, female land rights generated significant differences in all the categories other than yields, with those households with female land rights getting smaller-value harvests and a lower share of harvested value.

Looking at the overall picture, we can identify clear patterns along gender lines. Though female household heads and owners all sow less area and get less income from crops of either type and overall, as we have seen, this is mainly due to the fact that their farms are much

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[12] Sweet potato, manioc.

[13] For example, testing the difference of means of the area sown to each type of crop by the household head, I ran a generalized linear regression of the following model:

$$net\_farm\_income = \beta 1 female\_head + \beta 2 male\_head \quad (3)$$

if $\beta 1$ or $\beta 2$ are significantly different from zero, I say that female-headed or male-headed households receive significantly different net farm income than dual-headed households, the default category.

smaller—there is no evidence of significant differences in yields. Although female-headed households and households with female land rights sow more of their land in and get more of their harvested value from food crops, so do all other households. For other households this is not unusual—they get higher yields in food crops. But female-headed households and households with female land rights have higher average yields in cash crops than food crops. Economic rationality would lead farmers to specialize in the area they are most efficient. All else equal, female-headed households and households with female land rights should then specialize in cash crops. Of course, it may be that the difference in average yields is not caused by gender. I will now attempt to explain differences in crop yields. In this case, the dependent variable is food crop yield and cash crop yield, where yield is total harvested value divided by area sown to each type of crop. The model I estimate is:

$$\begin{aligned} Yield = {} & \beta_1 FLR + \beta_2 female\_head + \beta_3 male\_ head \\ & + \beta_4 FemaleYears + \beta_5 FemaleAge + \beta_6 MaleYears \\ & + \beta_7 MaleAge + \beta_8 AreaOw + \beta_9 AreaOp + \beta_{10} Capital \\ & + \beta_{11} numadult + \beta_{12} hhsize + \beta_{13} soil\_quality \\ & + \beta_{14} central + \beta_{15} colonizacion + \beta_{16} frontera \end{aligned} \qquad (2)$$

where *FLR* is the female land rights dummy variable, which is one for each household in which a woman holds title to land. *Female_head* and *Male_head* are the dummy variables for the sex of single household heads. *FemaleYears* is the number of years of education the female head received and *FemaleAge* is the age of the female head. *MaleYears* is the number of years of education received by the male head and *MaleAge* is the age of the male head. *CroppedArea* is the total area cultivated by the household, in hectares. *AreaOw* is the total area owned by the household, in hectares. *NoTitle* is a dummy variable taking the value one for households that own land without title. *AreaOp* is the total operational holdings, or farm size, in hectares. I include both farm size and area owned in order to differentiate the effect of how much land a household owns (the effect of property ownership) and how big a farm they have (the effect of the scale of operations). *Capital* is the value of productive assets owned by the household, in millions of G. *Numadult* is the number of adults in the household and *hhsize* is the total number of people in the household. The *soil_quality* variable is the index of soil quality for the

household's district. *Tech_ass_recvd* and *cred_ass_recvd* are the dummy variables signifying that a household received technical or credit assistance, respectively. *Central*, *colonizacion*, and *frontera* are regional dummy variables (*chaco* was dropped in all cases due to multicollinearity). Summary statistics for regression variables are presented in Table 5. For each crop, I test for multicollinearity using variance inflation factors and drop problematic variables from the model. I run the same specification for each crop (log of crop yield regressed on the log of the continuous independent variables) using the survey regression procedure. The regression results are presented in Table 6.

The regressions for these two crop yield variables could explain relatively little of their variation (R^2 for both food yield and cash yield was .04). In both cases, though, the F-statistic was significant at the 1% level. None of the estimated coefficients for the gender variables were significantly different from zero, though the signs for female land rights were positive and those for female heads were negative. In addition, the size of the marginal effect[14] of female land rights is small in both cases, while the effect of female headship on cash crop yields is larger. Food crop yields were significantly smaller with smaller farm sizes and greater with better soil quality (the largest marginal effect). Every region had significantly lower food crop yields than the minifundia region. To summarize the results thus far, we have seen that where women hold positions of greater importance in rural Paraguayan farm households (whether the head or a land owner), the emphasis in production is on food rather than cash crops. But as yet, no solid evidence of gender differentiation in crop yields, either for specific crops or for type of crops, is apparent. Next, I attempt to determine if differences in overall productivity can explain lower farm incomes for households with female land rights.

6. PRODUCTIVITY

I use two measures of productivity in this section. The first, land productivity (*LP*), is simply the total value of all agricultural production, net of costs, divided by the farm size (operated area). The second measure, the rate of return on assets (*P_K*), is similar except that the denominator in this case is total farm assets (land owned, capital equipment, etc.; see Equation 1, above). I regress each variable using the following specification:

$$\begin{aligned} Productivity = {} & \beta_1 FLR + \beta_2 female\_head + \beta_3 male\_head \\ & + \beta_4 FemaleYears + \beta_5 FemaleAge + \beta_6 MaleYears \\ & + \beta_7 MaleAge + \beta_8 AreaOp + \beta_9 Capital \\ & + \beta_{10} numadult + \beta_{11} hhsize + \beta_{12} soil\_quality \\ & + \beta_{13} central + \beta_{14} colonizacion + \beta_{15} frontera. \end{aligned} \qquad (3)$$

For both dependent variables, the log-log model was the best fit. However, since net farm revenue is negative for many of the farms in the sample, we have a selection problem (the log of a nonpositive number is undefined).[15] This introduces selection bias, which leads to artificially low standard errors if we use ordinary least squares regression analysis. This bias is addressed by using the Heckman two-step estimation procedure. This procedure follows Heckman (1979) by first performing a probit estimation using a dummy variable, *LPos,* for the land productivity regression and *PPos* for the rate of return regression, that takes the value of one if the land productivity or the rate of return are negative, respectively. The probit step uses different independent variables than those in Equation 3, above (*region*, *soil_quality*, *LandValue*, *MaleYears*, *FemaleYears*). The results of this estimation are then used in the second step to obtain consistent estimates for the coefficients of the independent variables (see Table 6).

First, notice that female land rights are estimated to significantly reduce return on assets, but not land productivity. Male experience leads to significantly higher rates of return. Farm size follows the stylized facts of the inverse relationship literature—it significantly decreases land

[14] Since this regression is log-log, the marginal effects are equivalent to the regression coefficients.
[15] The model I estimate for land productivity does not include *AreaOw* because testing for multicollinearity using variance inflation factors revealed that using area owned in this model was a problem.

productivity and significantly increases rates of return. The amount of assets is also estimated to significantly increase land productivity. Curiously, while higher soil quality is estimated to significantly increase land productivity, it is also estimated to significantly decrease the rate of return. Finally, farms in the central region have significantly lower rates of return on assets, while those in the colonization region have significantly higher land productivity.

So, in addition to lower net farm incomes, households with female land rights tend to have lower net farm incomes per hectare and rates of return on assets. Since I control for both land and capital equipment in the regressions, it is clearly not a matter of access to those resources that is the obstacle to women achieving higher incomes.

7. CONCLUSION

What we see then is more evidence that rural Paraguayan households with female land rights are somehow disadvantaged in terms of agricultural income, but the explanation remains elusive. We have seen that Paraguayan women and men have distinct patterns of agricultural production. Women concentrate more on livestock and associated byproducts, while men are more likely to cultivate crops. Still, if women were less efficient farmers, this could explain the disadvantage they have, despite the fact that they get less of their farm income from crops than men. However, there is no evidence to support that claim. There are, again, distinct patterns of cropping: women clearly emphasize food crops, and men grow more cash crops. However, there are still no significant differences between women and men in terms of cash or food crop yields. In terms of the land productivity and rate of return measures, households with female land rights do significantly worse in rates of return, but more than this we cannot say. So something related to ownership of land is a barrier to women getting higher incomes from farm activities, but lower proficiency at farming is not the explanation. Perhaps lack of control over land rather than its ownership is the cause of the disparity in incomes.

Given these results, two avenues present themselves for further exploration. First, a study of animal husbandry is clearly needed to understand the disadvantage women appear to have in the Paraguayan rural sector. Such an examination will tell us, for example, if a more efficient distribution of resources would be women doing the cattle raising and men doing the cultivation. In addition, a better idea of women's actual control over allocating resources (including their

own labor) is essential in order to understand the dynamics at work. More comprehensive data will help to tell more of the story. My measure of female management is, for the most part, a measure of relative female participation in agricultural production, and my measure of female land rights is a measure of the presence of female ownership, rather than a measure of effective rights (which would include direct control over land). Thus, while definite progress has been made in gathering data about gender in Paraguayan households, there is still room for improvement. Helpful extensions to data-gathering efforts include information about ownership by plot, information about decision-making by activity and plot, and more detailed information about production costs and their allocation among different activities and plots.

TABLES

Table 1: Number, Average Farm Size, and Area Owned of Owner-Operated Farms by Household Head, Land Owner, and Female Land Rights

	N	Percentage	Farm Size (Ha.)	Area Owned (Ha.)
Household Head				
Female	267	14.5%	8.287**	6.841**
Male	158	8.6%	27.672	24.199
Dual	1412	76.9%	16.786	13.630
Land Owner				
Female	195	10.6%	7.217*	5.455**
Male	755	41.1%	26.132*	22.684†
Joint	26	1.4%	15.321**	14.803**
Nonmember	155	8.4%	9.875**	8.502**
No Title	706	38.4%	10.616	7.461
Female Land Rights				
Some	221	12.0%	7.794**	6.121**
None	1616	88.0%	17.987**	14.843**
Total	1837	100.0%	16.556	13.618

Source: MECOVI 2001
Significance levels: † significant at 10%; * significant at 5%; ** significant at 1%
Note: Significance was tested using a generalized linear regression of the variable on dummy variables representing the different categories.

Table 2: Average Net Farm Income (millions G) by Source, Household Head, and Female Land Rights

		Net Farm Income (millions G)	Net Farm Income per capita (millions G/person)	Net Farm Income per Hectare (millions G/Ha)	Share from Crop (%)	Share from Cattle (%)	Share from Dairy (%)	Share from Processed (%)
Household Heads								
Female	*mean*	2.997**	0.895**	3.674	23.63%**	23.91%	45.97%**	6.36%
	median	1.560	0.447	0.716	12.00%	17.16%	46.80%	0.00%
Male	*mean*	4.867	2.895	4.028	44.22%	22.54%	27.88%	5.18%
	median	3.127	1.163	0.520	46.90%	8.79%	16.82%	0.00%
Dual	*mean*	7.388**	1.695	3.163	40.61%*	19.55%	31.86%	7.86%
	median	3.616	0.621	0.733	40.60%	12.37%	22.86%	1.40%
Female Land Rights								
Some	*mean*	3.253**	0.966**	5.374*	21.42%**	23.38%	50.00%**	5.20%*
	median	1.413	0.445	0.992	5.81%	14.44%	46.80%	0.00%
None	*mean*	7.053**	1.808**	2.980*	41.27%**	19.98%	30.85%**	7.76%*
	median	3.538	0.664	0.674	40.69%	11.88%	22.32%	1.26%
Total	*mean*	6.519	1.689	3.317	38.48%	20.46%	33.54%	7.40%
	median	3.113	0.613	0.706	35.76%	12.52%	24.19%	0.64%

Source: MECOVI 2001
Significance levels: † significant at 10%; * significant at 5%; ** significant at 1%
Note: Significance was tested using a survey linear regression of the variable on dummy variables representing the different categories.

Table 3: Area Sown and Share of Total Area Sown by Crop Type, Household Head, and Female Land Rights

		Food Crops			Cash Crops			Total
		Share of Farms (%)	Area Sown (Ha.)	Share of Area (%)	Share of Farms (%)	Area Sown (Ha.)	Share of Area (%)	Area Sown (Ha.)
Household Heads								
Female	*mean*	57.93%**	0.979**	33.87%	53.50%*	1.665*	26.88%**	2.644*
	median	100.00%	0.650	23.81%	100.00%	0.500	7.94%	1.220
Male	*mean*	79.48%	1.391	43.20%	74.85%	19.091	38.76%	20.482
	median	100.00%	1.100	45.47%	100.00%	1.315	40.00%	2.655
Dual	*mean*	78.51%†	1.434*	39.48%	72.80%	7.959	41.91%*	9.393
	median	100.00%	1.220	37.24%	100.00%	1.577	46.02%	3.013
Female Land Rights								
Some	*mean*	54.56%**	0.904**	30.33%*	47.69%**	2.391†	25.65%**	3.295*
	median	100.00%	0.610	4.99%	0.00%	0.520	0.00%	1.625
None	*mean*	79.06%**	1.432**	40.42%*	73.87%**	8.983†	41.70%**	10.415*
	median	100.00%	1.195	38.42%	100.00%	1.502	45.05%	3.000
Total	*mean*	75.62%	1.379	39.00%	70.19%	8.323	39.44%	9.702
	median	100.00%	1.110	37.36%	100.00%	1.500	41.93%	2.852

Source: MECOVI 2001
Significance levels: † significant at 10%; * significant at 5%; ** significant at 1%
Note: Significance was tested using a linear regression of the variable on dummy variables representing the different categories.

Table 4: Crop Value, Share of Total Crop Value, and Crop Yield by Crop Type and Household Head, Household Head and Female Land Rights

		Food Crops			Cash Crops			Total	
		Crop Value (millions G)	Share of Value (%)	Crop Yield (millions G/Ha)	Crop Value (millions G)	Share of Value (%)	Crop Yield (millions G/Ha)	Crop Value (millions G)	Crop Yield (millions G/Ha)
Household Heads									
Female	*mean*	0.953**	37.82%	2.067	1.048**	22.93%**	5.429	3.293**	5.072
	median	0.166	33.01%	1.425	0.024	4.75%	0.800	1.422	1.011
Male	*mean*	1.571	43.54%	1.878	18.582	38.42%	2.435	24.590	1.945
	median	0.730	37.99%	1.192	0.516	38.44%	0.960	2.694	1.235
Dual	*mean*	1.934**	44.40%	3.823	7.195	36.76%†	2.347	11.218	3.578
	median	0.980	43.84%	1.434	0.816	31.16%	0.954	3.683	1.194
Female Land Rights									
Some	*mean*	0.872**	33.68%*	2.488	1.367*	22.30%**	5.972	4.001*	5.458
	median	0.077	6.90%	1.625	0.000	0.00%	1.080	1.970	1.193
None	*mean*	1.904**	44.95%*	3.546	8.330*	36.96%**	2.350	12.462*	3.380
	median	0.963	44.00%	1.374	0.750	31.47%	0.936	3.329	1.189
Total	*mean*	1.759	43.36%	3.439	7.352	34.90%	2.696	11.614	3.588
	median	0.780	41.36%	1.400	0.504	28.33%	0.942	3.210	1.193

Source: MECOVI 2001
Significance levels: † significant at 10%; * significant at 5%; ** significant at 1%
Note: Significance was tested using a survey regression of the variable on dummy variables representing the different categories.

Table 5: Summary Statistics for Regression Variables

	Mean	Linearized Std. Errors	N
Food Crop Yield (Millions G/Ha.)	3.439	1.265	1511
Cash Crop Yield (Millions G/Ha.)	2.696	0.499	1443
Land Productivity (Millions G/Ha.)	3.317	0.564	1835
Net Farm Profits Divided by Assets	0.813	0.097	1837
Female Land Rights (%)	14.042	1.446	1837
Female-only Head (%)	14.498	1.613	1837
Male-only Head (%)	9.203	1.332	1837
Years of Experience, Female Head	37.650	0.697	1679
Years of Experience, Male Head	40.845	0.843	1570
Area Owned (Ha.)	13.618	2.348	1837
Area Operated (Ha.)	16.556	2.538	1837
Capital Eq. (millions G)	11.963	2.424	1837
Number of Adults in Household	2.741	0.052	1837
Size of Household	5.246	0.115	1837
Soil Quality Index (0 - worst; 1 - best)	0.412	0.018	1763
Central Region (%)	36.437	5.381	1837
Minifundia Region (%)	13.379	1.957	1837
Colonization Region (%)	22.604	3.595	1837
Frontier Region (%)	26.324	3.817	1837
Chaco Region (%)	1.256	0.410	1837

Source: MECOVI 2001

Table 6: Regression Results for Land Productivity and Rate of Return

	Food Crop Yield	Cash Crop Yield	Land Productivity	Rate of Return
Female Land Rights	0.01	0.056	-0.025	-0.653
	(0.159)	(0.172)	(0.129)	(0.217)**
female_head	-0.017	-0.197	-0.28	0.524
	(0.157)	(0.18)	(0.177)	(0.394)
male_head	0.023	-0.058	0.26	0.298
	(0.145)	(0.148)	(0.215)	(0.205)
logFemaleExp	0.095	-0.107	-0.006	-0.019
	(0.153)	(0.141)	(0.167)	(0.248)
logMaleExp	0.051	-0.238	-0.162	0.558
	(0.16)	(0.161)	(0.208)	(0.247)*
logAreaOW	-0.02	0.006		
	(0.04)	(0.071)		
logAreaOP	-0.134	-0.065	-0.692	0.613
	(0.053)*	(0.068)	(0.047)**	(0.094)**
logCapital	0.087	-0.006	0.216	-0.113
	(0.030)**	(0.067)	(0.042)**	(0.099)
Number of Adults in Household	0.014	0.063	-0.003	-0.131
	(0.036)	(0.049)	(0.033)	(0.053)*
Size of Household	0.006	-0.037	0.047	0.141
	(0.017)	(0.023)	(0.014)**	(0.037)**
Soil Quality Index (0 - worst; 1 - best)	0.583	0.11	0.281	-0.999
	(0.195)**	(0.227)	(0.148)†	(0.399)*
central	-0.298	0.269	-0.112	-1.043
	(0.097)**	(0.165)	(0.109)	(0.267)**
colonizacion	-0.226	-0.137	0.139	0.195
	(0.117)†	(0.106)	(0.082)†	(0.131)
frontera	-0.301	-0.009	0.136	0.194
	(0.117)*	(0.151)	(0.098)	(0.202)
Observations	1473	1412	1763	1763
R-squared	0.05	0.04		

Source: MECOVI 2001
Standard errors in parentheses
† significant at 10%; * significant at 5%; ** significant at 1%

REFERENCES

Agarwal, Bina. 1994. *A Field of One's Own: Gender and Land Rights in South Asia*. Cambridge: Cambridge University Press.

Binswanger, Hans P., Klaus Deininger, and Gershon Feder. 1995. "Power, Distortions, Revolt and Reform in Agricultural Land Relations." in J. Behrman and T.N. Srinivasan (eds.) *Handbook of Development Economics, Volume III*. Amsterdam: Elsevier Sciences B.V.

Deere, Carmen Diana, Rosaluz Dura'n, Merrilee Mardon, and Thomas Masterson. 2005. "Female Land Rights and Rural Household Incomes in Brazil, Paraguay, and Peru." *Agriculture and Rural Development Internal Report.* Washington, DC: World Bank.

Deere, Carmen Diana, and Magdalena León. 2001. *Empowering Women: Land and Property Rights in Latin America*. Pittsburgh, PA: University of Pittsburgh Press.

————. 2003. "The Gender Asset Gap: Land in Latin America." *World Development* 31(6): 925–947.

Doss, Cheryl R. 2001. "Designing Agricultural Technology for African Women Farmers: Lessons from 25 Years of Experience." *World Development* 29(12): 2075–2092.

————. 2002. "Men's Crops? Women's Crops? The Gender Patterns of Cropping in Ghana." *World Development* 30(11): 1987–2000.

Heckman, James. 1979. "Sample Selection Bias as a Specification Error." *Econometrica* 47(1): 153–162.

Jacoby, Hanan G. 1992. "Productivity of Men and Women and the Sexual Division of Labor in Peasant Agriculture of the Peruvian Sierra." *Journal of Development Economics* 37(1–2): 265–287.

Lastarría-Cornhiel, Susana. 1988. "Female Farmers and Agricultural Production in El Salvador." *Development and Change* 19(4): 585–616.

Moock, Peter R. 1976. "The Efficiency of Women as Farm Managers: Kenya." *American Journal of Agricultural Economics* 58(5): 831–5.

Quisumbing, Agnes R. 1996. "Male-Female Differences in Agricultural Productivity: Methodological Issues and Empirical Evidence." *World Development* 24(10): 1579–1595.

Tibaijuka, Anna. 1994. "The Cost of Differential Gender Roles in African Agriculture: A Case Study of Smallholder Banana-Coffee Farms in the Kagera Region, Tanzania." *Journal of Agricultural Economics* 45(1): 69–81.

Udry, Christopher. 1996. "Gender, Agricultural Production, and the Theory of the Household." *The Journal of Political Economy* 104(5): 1010–1046.

Udry, Christopher, John Hoddinott, Harold Alderman, and Lawrence Haddad. 1995. “Gender Differentials in Farm Productivity: Implications for Household Efficiency and Agricultural Policy.” *Food Policy* 20(5): 407–23.