If women hold up half the sky, how much of the world's food do they produce?

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Abstract: This paper explores, conceptually and empirically, the question of how much food is produced by women. Data for labour inputs and agricultural output are used to assess women's contribution to food and agricultural production. The study also assesses gender differences in productivity. The paper finds that a precise measure of women's contribution to food production is impossible to establish. In general women do not produce food separately from men and it is impossible to disaggregate men and women's contributions either in terms of labor supplied or in terms of output produced. Ultimately the precise contribution women make to food production is irrelevant. It is enough to recognize that women are important to agriculture and agriculture is important to women. There is evidence that shows that women farm as productively as men do, when they have access to the same resources. But they often do not have access to the improved technologies, credit, land and other resources. Additional data is needed to understand better women's roles and constraints in agriculture so as to appropriately design interventions that target women.

Key words: Women, gender, labor, food production, agriculture, productivity, data, time use.

JEL: Q10, J16, J21, J22, J24,

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INTRODUCTION

"Women produce between 60 and 80 percent of the food in most developing countries and are responsible for half of the world's food production."(FAO, 1997)

This statement is widely quoted and used – in varying phrasings and rephrasings – as justification for focusing attention on women farmers throughout the world. Referring to the same FAO document cited above, a similar claim is that "Rural women produce half of the world's food and, in developing countries, between 60 percent and 80 percent of food crops (Mehra and Rojas, 2008)." It has also been adapted to claim, "Women produce more than half of the locally-grown food in developing countries and as much as 80 per cent in Africa (Momsen, 1991, p. 2)." Possibly the earliest related claim was published in 1972, "Few persons would argue against the estimate that women are responsible for 60-80% of the agricultural labour supplied on the continent of Africa…(UNECA, 1972)" And a recent newspaper column claims, "In reality, half of the world's food and, in developing countries, between 60 and 80 percent of food crops, grow from seeds that are planted by a woman's hand (Gupta, 2009)."

While all of these claims represent a powerful truth –women are important food producers – the empirical content behind them is less clear.[2] Instead, they should probably be viewed as a metaphor, much like the claim Women hold up half the sky." In addition, each of these claims about women's contribution to food production makes a very different empirical claim. Food production would certainly include both crop and animal products and could include processing and preparation. The claim about women producing locally grown food suggests that in developing countries women are the primary producers of food that is grown and consumed locally.[3] The 1972 claim simply refers to women's labor inputs in agriculture (presumably measured by the number of workers or the number of hours worked), and doesn't address the amount of output that they produce. The metaphor of seeds planted by a woman's hand is also a

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[2] The one reference that indicates that these numbers are not accurate is Jackson (2005), who says, "It is interesting that this statement is so enduring, so effective—*and so wrong*…"

[3] It is not clear what it would mean for food *not* to be locally grown. Usually the context implies that it is consumed near where it is produced.

powerful one, but it leaves out most of the additional steps of food production, such as weeding and harvesting.

In this paper, I explore various sources of data that can tell us something about the "stylized fact" that women produce 60-80% of the food in developing countries. One central argument of the paper is that a claim of this kind does not have any literal meaning, and it does not lend itself to direct empirical tests. Women do not in general produce food separately from men. Quantifying the share of food produced by women involves making many arbitrary assumptions about gender roles in the production process. Since most food is produced with labor contributions of both men and women, to assign the output separately to men and women would be very complex. To take a stylized example, if men provided the labor to clear the field, women planted and weeded the crops, and both men and women were involved in harvesting, how would we determine how much of the output was produced by women?

Empirically, this becomes even more of a challenge. Even if the concept were clearly defined, there are not adequate global data to measure the share of food produced by women. Considering only the labor contributions of men and women in crop production – and setting aside gendered patterns of land ownership and control over other resources – we would need very detailed agricultural production data that included labor inputs for different tasks for men and women and agricultural outputs across a wide range of production systems. If we were interested in the contributions to the final food products that people eat, rather than the crops that are harvested, we would need data on the labor inputs in food processing and preparation. As more of this moves out of the home into the commercial sector, we would have to estimate production functions that included sex and task disaggregated data in the commercial food processing and production sectors. The level of detail needed for this type of analysis is far beyond what is currently available. And we would still have to match the labor inputs to outputs. This would be a formidable task and one that would not necessarily help to illuminate important policy questions.

In spite of these difficulties, there is a range of data available on labor inputs and on agricultural output that can help to shed light on women's contributions to food and agricultural production.

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In this paper, three different bodies of empirical literature and data are used to explore this contribution. First, the paper analyzes the labor inputs to agricultural production, using both employment data and time use data. Second, using four nationally representative household survey data sets, it examines several different ways to assign agricultural output by gender, including the gender of the household head, the owner of the land and the decision-maker or farm manager. Third, national level agricultural productivity data across time and countries is used to estimate women's labor productivity relative to that of men at the macro level. These macro-level estimates are then compared to micro-level evidence on men's and women's agricultural productivity. Thus, unlike the claim that "women hold up half the sky," there is considerable information on women's contributions to food production.

Because of the available data, a variety of different measures of both inputs and outputs are used in this paper. Each of the measures has its own limitations and strengths. Outputs include both crop production and agricultural production. Crop production excludes animal products – notably milk, eggs, and meat. Agricultural production includes not only food production, both crop and livestock, but also the production of goods such as fiber and flowers. Thus, neither one is a specific measure of food.

None of the analyses presented here differentiates between subsistence production and commercial or export production. Food is produced in all of these sectors. Many types of food are produced by smallholder farmers both for home subsistence consumption and for sale in the market. Many of the discussions about the importance of women's role in food production in developing countries stress women's important role in growing, processing, and preparing the food to feed their families. This is typically portrayed as different – and perhaps more important – than the work that women provide in the commercial and export sectors.

Another measurement issue faced in this paper concerns the use of the aggregate term "food". There are, of course, many types of food, including (literally) apples and oranges. The approach that is used here for aggregation is the standard one of adding the monetary value of each type of food. That lets us come up with a consistent aggregate, but implicitly it assigns high weights to the more expensive items. Other methods of aggregating across different food categories might

result in very different totals. For example, if we aggregated by the caloric value, then starchy high-calorie staple crops would have a higher value than crops such as coffee which have a higher monetary value. To the extent that women tend to be more heavily involved in the production of staple crops, comparing the caloric value of the food produced by men and women might indicate a significantly higher share being produced by women. This aggregation becomes more of a challenge if we are considering food on the table, rather than simply agricultural products. Much of the work of processing and preparing food for the table is done outside of the market sector, and thus more difficult to value consistently in monetary terms.

MEN'S AND WOMEN'S LABOR INPUTS TO AGRICULTURAL PRODUCTION

Food production requires a number of different factors of production, including labor, land, and capital, as well as inputs and intermediate goods such as animal and mechanical power, seeds, fertilizer and water. The claim about women's contributions to food production is often made in a context in which it appears to be referring simply to labor inputs and comparing men's and women's labor inputs, rather than considering a more complete range of inputs. In this section, I examine the labor inputs of men and women in agricultural production.

The most comprehensive data available are the FAO data on the economically active population in agriculture. In this measure, an individual is reported as being in the agricultural labor force if he or she reports that agriculture is his or her main economic activity. Sex-disaggregated data are available for most countries. Table 1 presents these data for 235 countries for the period 1961 to 2006. The unweighted averages simply use each country and time period as an observation. They can be weighted by the size of the agricultural labor force.

Using these measures, the proportion of the agricultural labor force that is female is less than 50% for the world as a whole and for all the usual country groups. Overall, using the weighted measure, women are only 42.2% of the agricultural labor force. Even for sub-Saharan Africa, which is the region where women are typically most involved in agricultural production, these

measures suggest that women make up fewer than half of the number of people who are reported as economically active in agriculture.

Many researchers have questioned the gender patterns that emerge from this data. In particular, the reported 16% share for women in Latin America is strikingly low. Deere (2005) identifies a number of potential sources of under enumeration of women in agriculture. In particular, she notes that rural women in Latin America are likely to reply that "their home" is their primary responsibility, even if they are heavily engaged in agriculture. Other difficulties arise because the censuses tend to emphasize income generating activities, underestimating subsistence production; and because agricultural production is often defined as field work, so that activities such as rearing small livestock, kitchen gardening, and post-harvest processing are undercounted.

While Deere focuses on critiquing the numbers for Latin America, similar criticisms are relevant for other regions. Using household survey data collected by the Comisión Económica para América Latina y el Caribe (CEPAL), Deere (2005, p. 21) re-calculates the female fraction of the population occupied in agriculture in 1999 for eleven Latin American and Caribbean countries. She finds percentages ranging from 3.7% in Panama to 44.7% in Brazil. Overall 26.2% of those reporting themselves as occupied in agriculture are women.[4] While this is substantially more than the 16% in the FAO data, the numbers still fall far short of the 60-80 % benchmark.

Using the FAO data, only six countries report that 60% or more of the agricultural workforce is women.[5] Somewhat surprisingly, these are not African countries in which women work on smallholder farms, but instead they are primarily Middle Eastern countries where women work as wage laborers in agriculture.

Thus, although these data are problematic and probably substantially underestimate women's role in agriculture, they do not support the idea that women produce most of the world's food.

Evidence from Time Use Studies

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[4] Katz (2003) has similar estimates.
[5] These include Congo, Jordan, Libya, Palestinian Territory, Portugal and Turkey.

One shortcoming of data on women's share of the agricultural labor force is that these data do not account for differences in hours worked. If men who are identified as part of the "economically active population in agriculture" provide fewer hours of agricultural labor than women in the same sector, we could underestimate the importance of women. For example, some literature suggests that men in Africa work fewer hours than women, across all activities.(Blackden and Wodon, 2006).

To address this possibility, we can look at detailed time use studies that document the time that men and women spend in agriculture and in other activities. The detailed time use studies, especially those that include activities for more than one agricultural season, are usually for very small samples. Many studies are now quite old. While some nationally representative time-use studies have been recently collected, the reports do not provide summaries for time spent in agricultural activities.[6]

Table 2 summarizes a number of time use studies for which it is possible to calculate the share of total time spent in agricultural activities that is provided by women. Some of the reported numbers are just for crop production, while others include animal agriculture. These studies all support the claim that women are heavily involved in agricultural production, with the exception of the study of West Bengal. In some regions within Africa, women do contribute over 60% of the total time spent in agricultural activities. Yet there is wide variation across sites and across seasons within sites. And overall, there is no support for the 60-80% figure at a global scale.

Only a few of the studies report the time spent in other food production activities, such as food processing and preparation (See Table 3). Time spent cooking and cleaning is often reported as a single entry, so we cannot separate out the portion that is allocated to food preparation. In one study, fuel and water collection are treated as food preparation activities, but cooking is not included. In others, cooking is combined with other household chores, such as cleaning, so we cannot separate out the time spent in food preparation. Nevertheless, the limited evidence

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[6] For example, a discussion of these studies in Africa by Charmes (2006) provides an analysis of the non-market time spent in agricultural activities, but does not include the measure of agricultural activities in the market sector.

suggests that women are the ones who overwhelmingly provide the greatest proportion of time to food processing and preparation.

The time use studies are able to give us a sense of how men and women allocate their time across various activities. They are not able to tell us anything about the productivity of that labor, nor do these data provide a means to map the labor inputs into specific outputs. In other words, we are still faced with the question of whether women providing 54% of the total household hours devoted to agriculture can be interpreted to mean that they have produced 54% of the agricultural output. An additional concern with the time use studies is that they are not necessarily drawn from representative samples, so that it is difficult to make meaningful inference to national or international populations. Finally, many of the studies are quite old and the employment patterns in rural areas are changing. They probably still reflect women's time allocation in the subsistence farming sector, but may be less reflective of areas where commercialization is occurring.

To summarize however, the time use studies do suggest (but do not actually demonstrate in any statistical sense) that if "food production" includes food processing and preparation, then women probably provide 60-80% of the total labor used in bringing food to the table in developing countries. But if "food production" refers instead to the cultivation and harvest of food crops, or to the labor used in producing unprocessed agricultural outputs, women probably do not account for the majority of hours worked.

The time use studies also leave unanswered the question of whether men's and women's labor is complementary. Are both required for agricultural production? Or are they entirely substitutable? Social norms, customs, and technologies all impact the extent to which they are complements or substitutes. These differ across and within countries, and these social relationships are not fixed over time.

One final approach to examining women's labor contributions would be to look at the share of agricultural wages that women receive. If men and women were each paid the marginal value of their labor, then the wages would represent their contributions to agricultural output. Unfortunately, this approach would have two problems. First, it would only count agricultural

labor in the wage sector, ignoring the unpaid family labor that characterizes much of the agricultural sector worldwide. Second, it would require the assumption that men and women are actually paid their marginal value and that labor markets are competitive. Particularly based on evidence coming out of Latin America,[7] it is clear that the agricultural labor markets are segmented, with women concentrated in jobs that are low paid and seasonal. Similar wage differentials are found in India (Ganguly, 2003; Jose, 1988). There are sufficient claims of gender discrimination in agricultural labor markets to indicate that this would significantly undercount women's contributions.

MEASURING MEN AND WOMEN'S AGRICULTURAL OUTPUT

If we focus our attention on agricultural output instead of labor inputs, we might try to quantify how much output is produced by men and how much by women. This is complicated, however: as noted above, in many agricultural households, both men and women are involved in crop production, so it is a challenge to determine which individuals are producing it. To compare outputs across men and women, we need a way to assign agricultural outputs by gender. In order to examine this question, household survey data is used from four countries: China, Bosnia-Herzogovenia, Ghana and Nicaragua. These countries were chosen because available household survey data allow for analysis using multiple measures of assigning output to men and women. There are relatively few nationally-representative household surveys that meet this criterion.

For China, the data come from the China National Rural Survey – a nearly nationally representative sample of 60 villages in six provinces of rural China surveyed during November and December 2000. The numbers presented here are based on the definitions and estimations presented in De Brauw et al., (2008).

The Bosnia-Hergovenia data come from the Living Standards Measurement Survey (LSMS) conducted in 2001. The value of the crops (including vineyards and orchards, but not pastures) is based on the amount harvested during the 2000-01 season.

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[7] See Deere (2005) and Lastarria-Cornheil (2009) for reviews of this literature and Jarvis and Vera-Toscan (2004) for an econometric analysis of agricultural wages in Chile for men and women.

Similarly, the Ghana Living Standards Survey (1998-99) was used to calculate the value of crops produced on land farmed by the household and to calculate the value of crops grown on land held by different individuals. Finally, the Nicaragua data come from the MECOVI survey, a nationally representative survey conducted in 2001 (Gobierno de Nicaragua, 2001) The value of the crops produced includes that produced on the agricultural production unit (UPA) and on the *patio* or backyard garden.

None of these surveys provides an adequate means to calculate the value of food processing and preparation. While they do include measures of food processing and preparation for items produced for sale; they do not include a value of that produced for home consumption. As a result, the discussion that follows focuses on the value of crop output.[8]

As a lower bound on women's production, the output could be assigned to women if the crop was produced in a household headed by a woman. While women frequently live in male-headed households, the definition of a female-headed household usually precludes the possibility than men are members of the household. While these female heads may use some male labor on their farms, either from a male relative or through hired labor, it would be reasonable to treat this as output produced by women.

Table 4 shows the share of the value of crops produced by female headed households in these four countries. The proportion of households that are reported as female headed vary from 3.1% in China to 38% in Nicaragua. Yet, in each country, the value of crops produced by female-headed households is less than would be expected if male and female headed households produced the same amount of crops. This is, at least in part, because female headed households are typically smaller (in numbers of people) and have less access to resources (including land and labour) than male headed households.

This measure ignores the food produced by women living in male-headed households, but given that female-headed households produce proportionately low amounts of crop output, these

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[8] Livestock products are also not included in this section of the analysis.

numbers cast some doubt on the stylized fact that women produce 60-80% of agricultural output. Even in the country with the highest level of female-headed households, Nicaragua, to reach the 60% threshold, women would have to produce 57% of the food in male-headed households. While this is not outside the realm of possibility, it would be a surprisingly high number.

Another way to assign output to men and women is to allocate it to the owner of the plot of land. In Bosnia-Herzogovenia, 16% of plots were reported as owned by women. Of the total value of crops produced, 16% were grown on plots owned by women.

A final approach is to look at the person who is the manager, decision-maker or person responsible for the agricultural production in a household or on a particular plot.

For Ghana, we have data on the person reported as the holder of each plot and what is grown. In 16% of male headed households and 56% of female headed households, at least one plot of land is held by a woman. Of the total value of crops produced, 15 % is grown on plots that are held by women.[9]

In Nicaragua, we can look at several different measures. For each agricultural production unit, we have data on which household member is the primary decision-maker and for each *patio*, we have data on the person responsible for this production. For each household, there may be more than one agricultural production unit, each with a different decision-maker. Assigning the production to the individual who is the decision-maker for the agricultural production unit or the person responsible for *patio* production, 17.6% of the total value of crops are produced by women.

For China, two measures of female management of farms are used, based on definitions from de Brauw, Liu, Rozelle and Zhang (2008). The first considers women as the managers of the farm based on the employment history of the husband and wife. Using this definition, 16% of the plots

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[9] While the data is also available on land owned by men and women, it isn't possible to sort out which outputs are produced on land that is owned by an individual, separate from that simply held by them.

were managed by women, and 13% of the crop revenues were produced on the plots managed by women.

In addition, de Brauw, Liu, Rozelle and Zhang (2008) create a measure of women's management based on the number of hours that women put in to farm labor compared with their husbands. The farm is considered to be managed by the woman if farm work is her primary occupation and if the man had primary work off the farm or worked on the farm only during the harvest season. In this case, women manage 9% of the plots, and generate 8% of the revenue.

All of these measures considerably underestimate women's contributions to agricultural output, because they do not include the labor of women working in male-headed households, on male-owned land or on male-managed farms. While they should not be used to suggest that women do not contribute substantially to food production, they also do not provide empirical evidence that women are the primary food producers.

A final way to allocate output by gender would be if we could assume that specific crops were grown by women and others were grown by men. Then we could aggregate the value of women's crops and men's crops to see the share grown by women. Researchers have occasionally used this approach, especially in West Africa, where there are patterns of cropping by gender.[10] Yet, a careful analysis of agriculture in Ghana finds while there are gendered patterns of cropping, the distinctions between men's and women's crops do not hold up well enough to use them to make inferences about men's and women's incomes (Doss, 2002). In addition, we know that gendered patterns of cropping may change over time as crops move from subsistence foods to commercial foods or vice versa.

WOMEN'S LABOR PRODUCTIVITY

The preceding approaches to calculating women's contributions to agricultural production do not speak of the labor productivity of women. Ideally, we would like to assess labor productivity in

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[10] For example, Hoddinott and Haddad (1995) and Duflo and Udry (2001) use gender patterns of cropping in Côte d'Ivoire to separate men's and women's incomes.

some way other than simply counting hours of work. As noted above, wages in agriculture may be a poor measure of relative productivity, because labor markets may not accurately value women's productivity and because some (perhaps most) of women's labor inputs in food production takes the form of non-market activities. Even if women are less than half of the agricultural labor force (measured as the proportion of the economically active people who report their primary activity as agriculture) or if women do not provide the majority of total hours worked in agricultural production, it may be that their contributions are particularly critical.

One approach that might help to assess the value of women's time would be to estimate agricultural production functions at the farm level, using micro data and treating women's time as a separate input from men's time. However, neither time use studies nor household survey data typically provide sufficient information to make these estimates on a systematic basis across countries.

Macro Evidence

One approach would be to use cross-country panel data to estimate agricultural production functions that include a measure of women's share of labor in agriculture. The coefficient on this variable could then be used to calculate a measure of women's effective share of agricultural labor. Thus, if men's labor and women's labor had different impacts on agricultural output, we could capture this.

This section uses national-level measures of agricultural productivity and women's share of labor in agriculture to measure the productivity impacts of women in agriculture. This work follows in the footsteps of numerous previous studies that use cross-country regressions to estimate aggregate production functions for the agricultural sector. Almost without exception, these papers are subject to the criticism that they suffer from endogeneity and simultaneity biases. Unfortunately, there are not alternative identification strategies that avoid this criticism, and

instrumental variables techniques are not useful because it is difficult to find plausible instruments to use to in these estimations.[11]

The basic structure of the econometric specification used in most of the literature on cross-country agricultural productivity differences[12] is given by a Cobb-Douglas production function in log terms:

$$\ln Y_{it} = \ln A_{it} + \sum_{j=1}^{P} \alpha_j \ln X_{ijt} + \phi \ln R_{it} + \beta \ln L_{it}$$

where Y_{it} is agricultural output, X_{ijt} are a set of inputs (livestock, tractors, fertilizer), R_{it} is land and L_{it} is labor; i indexes countries and t indexes over time. Dividing through by labor, we obtain:

$$\ln \frac{Y_{it}}{L_{it}} = \ln A_{it} + \sum_{j=1}^{P} \alpha_j \ln \frac{X_{ijt}}{L_{it}} + \phi \ln \frac{R_{it}}{L_{it}}$$

For this exercise, we are interested in the potential impact of women's share of labor on agricultural productivity. We might expect that reported women's agricultural labor has a different impact on agricultural output than men's labor. Thus, we treat women's share of labor as an externality in the model. This formulation allows us to empirically test this across time and country.[13]

We can estimate a model of the form:

$$\ln y_{it} = \ln A_{it} + \sum_{j=1}^{P} \alpha_j \ln x_{ijt} + \phi \ln r_{it} + \gamma \ln S_{it}^{F} + \varepsilon_{it}$$

Where S_{it}^{F} is the share of women in the agricultural labor force (female economically active population in agriculture divided by the total economically active population in agriculture.)

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[11] The econometric estimations all were done both with and without a measure of GNP per/capita. This is occasionally used as a measure of labor quality, but is certainly simultaneously determined with agricultural output per worker in the agricultural labor force. While lagged GNP could be included, the levels are still highly correlated with agricultural output per worker. The coefficients on women's share of labor were robust to the inclusion or exclusion of this variable.

[12] For example, see Craig, Pardey and Roseboom (1997), Wiebe et al., (2000), Vollrath (2007).

[13] This specification assumes constant returns to scale in the production technology.

The output measure is the value of net agricultural production in dollars divided by total economically active population in agriculture. While we are primarily interested in the coefficient on women's share of the agricultural labor force, we need to control for a variety of other factors that impact agricultural productivity. Land is measured as the total agricultural area in hectares. Fertilizer is measured in metric tons. We include a measure of the total number of agricultural tractors in use. Livestock is the total number of livestock, (aggregated with weights used in Hayami and Ruttan (1985)). In addition, to take land quality into consideration, we use the total area equipped for irrigation divided by the total agricultural area, and the total arable land divided by the total agricultural area. Each estimation also includes both indicators for the year, to control for time trends, and for the country to control for country fixed effects.[14] The observations are unweighted, each country and year is a single observation in the estimation. Data from 154 countries for each year from 1961-2002 results in 5305 observations.

The full results are presented in Appendix Tables 1 and 2. The coefficients on share of female labor are in Table 5. For the world as a whole, over the period 1961-2002, there is a positive coefficient of .08 on the proportion of women in the agricultural labor force. This suggests that, at the margin, the average productivity of a woman reported as being in the agricultural labor force is 1.08 that of men. If we calculate this across all time periods and countries, women's labor contributes 37.7-45.6 percent of the labor share of agricultural output, depending on whether we use unweighted or weighted averages.

The estimated coefficients are also calculated by region of the world. The coefficient for Latin America is quite high, .42, which corresponds with the research discussed earlier that indicates that women are undercounted in the agricultural labor data. For Africa, effective labor productivity of women is 53-54%. The effective shares of women's agricultural labor are higher for developing countries than for developed countries; and for low-income countries compared to high income countries. This may primarily reflect the undercounting that is more likely in subsistence and smallholder production than in commercial agricultural production.

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[14] Using the indicator variables for the year does not impose the structure of a smooth growth rate that would be implied by including a time trend; this is a more general specification.

These estimated differential contributions to output could be the result of a number of factors. We expect that women are undercounted in the national level data on employment in agriculture. Thus, each woman reported in the data may actually represent additional women providing labor. To the extent that men and women perform different agricultural tasks that have a different impacts on productivity, the coefficient on women's labor might be significant. Finally, because of social norms, other responsibilities, etc. men and women's measured labor could enter the production function differently. Each woman measured in the data could be involved in other tasks that are complementary or competing with the actual time and effort spent in agricultural production.

Of course it is also true that women's participation in agricultural labor is itself endogenously determined. In countries with good institutions, it may be the case that women have more ability to participate in the labor market. These institutions might include good governance, rule of law, well-functioning state institutions and markets, and political, social and economic freedoms. This might lead to a correlation between women's labor force participation and productivity levels, but both would essentially be driven by institutional quality. Nevertheless, the correlation is itself interesting.

Micro evidence

There is an extensive microeconomic literature comparing men's and women's productivity in agriculture. Quisumbing reviews the methodology and results of such studies and concludes, "female farmers are equally efficient as male farmers, once individual characteristics and input levels are controlled for (Quisumbing, 1996, p. 1590)." These inputs include quality and quantity of land, fertilizer, improved varieties, extension services and credit. For example, the study cited above on China finds that they cannot reject the null hypothesis that women are as efficient as farm managers as men, using several different definitions of women as farm managers.

Peterman, Quisumbing and Behrman (2010) propose a decomposition of the gender differences in productivity to determine whether the differences in levels of output are due to differences in resource endowments or due to men being able to use a given set of resources more efficiently.

They attribute productivity differences in Nigeria and Uganda to both of these factors. They argue that choices of crop, technologies used, and management techniques are all endogenous to the production decisions and influenced by gender.

The adoption of technologies for agricultural production frequently differs by gender.[15] Much of the literature on agricultural technology adoption simply demonstrates that women are less likely to adopt these technologies, without exploring why these gender differences exist. Doss and Morris (2001) examine the case of improved maize technology in Ghana and find that the gender differences are a result of the gender linked differences in access to complementary inputs. They also find that famers living in female-headed households are less likely to adopt improved technologies than farmers, whether male or female, living in male headed households.

It is important to note here that even if women were exactly as productive as men, given the same access to resources and inputs, we would expect to see women producing lower levels of output precisely because they have much less access to these resources and inputs.[16] Women often produce food on small plots of land of relatively poor quality, with limited access to improved technologies, credit or information. Thus, their output, whether calculated per unit of land or per unit of labor is typically lower than that for male farmers.

The macro and micro evidence reported here are not necessarily contradictory. The macro evidence – suggesting that aggregate productivity rises with the proportion of women in the labor force – may simply reflect the fact that women's labor is underrepresented in the macro data. Thus, each woman reported in the data may actually reflect additional women whose labor is unreported.

CONCLUSIONS

Overwhelming empirical evidence points to the importance of women as agricultural producers. Although it is not possible to substantiate the claim that women produce 60-80% of the food in

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[15] See Doss (2001) for a review of this literature on Africa.
[16] See Peterman *et al*, (2010) for a review of the literature on non-land agricultural inputs.

developing countries – or even that they provide 60-80% of the labor in agriculture, this should not be interpreted as evidence that women are insignificant in the agricultural sector. In fact, given women's continuing lack of access to secure land tenure, cash and credit for inputs, and information about new technologies, and given their primary responsibility for many other household tasks, it would be surprising if they were able to produce over half of food crops. Even if women *did* produce over half of food crops, it would be even more surprising – given the measurement challenges – if the data supported this claim. Instead, we see that women contribute a large portion of the measured contributions to agriculture labor and the women's share of the measured agricultural labor forces has a positive impact on national level agricultural productivity.

And while women are not the majority of those reported to be working in agriculture, the agricultural sector is important for women. Of those women in the least developed countries who report being economically active, 79% of them report agriculture as their primary economic activity. Overall, 48% of the economically active women in the world report that their primary activity is agriculture.[17]

Better data are needed, but data should not be collected simply to demonstrate women's contribution to food production. Instead, better data are needed to document the constraints that women face. Data collection has improved substantially since the 1972 UNECA estimate that "women are responsible for 60-80 % of the agricultural labour supplied on the continent of Africa." Among other advances, we have learned that to understand women's roles in agriculture, we need to ask not only about their primary economic activities, but about all the activities in which women engage. In addition, data are needed to better understand gender roles in agriculture and how they change over time and in response to new opportunities. Simply finding a better way to calculate women's share of food production will not necessarily help us to understand how gender roles and responsibilities shape agricultural production.

Ultimately, the important issue is not whether women produce 60-80% of the world's food. We know that women are important as food producers, and we know that development efforts that

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[17] FAOSTAT.

target food and agriculture must recognize the unique roles and constraints that face women. We also know that interventions targeting women are complicated. The stylized fact that women produce 60-80% of the world's food resonates with many people – researchers, policy-makers and activists – who work on rural women's issues. But perhaps the statistical claim obscures the complex underlying reality, which is that women's labor in agriculture cannot be neatly separated from their other time uses; neither can it be separated from men's labor; nor can women's labor in agriculture be understood properly without also understanding their differential access to land, capital, assets, human capital, and other productive resources.

For many reasons, we need to support women as food producers and to ensure that the structural changes now underway in world agriculture benefit women, as well as men, both as producers and consumers of food.

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Table 1. Share of Women in the Agricultural Labor Force, 1961-2006.

	Weighted	Unweighted
World	42.2	34.9
Developed countries	42.1	34
Developing countries	42.3	35.2
Low-income countries	42	46.3
High-income countries	36.4	31.3
Asia	42.9	42
Latin America & Caribbean	16.2	16
Near East and North Africa	42.1	31.8
Sub-Saharan Africa	46.5	47.1

Source: FAOSTAT

Note: Weighted results adjust for differences in agricultural labor force.

Table 2. Proportion of Total Time in Agricultural Activities Contributed by Women

Definition of Activity and Location	Women's share	Source
Agricultural Activities -- Burkina Faso	0.54	Saito
Agricultural Activities – Kenya	0.59	
Agricultural Activities – Nigeria	0.56	
Agricultural Activities – Zambia	0.54	
Crop production -- Cameroon	0.58	Leplaideur[18]
Ag production -- SW Cameroon (small dry season)	0.73	Charmes[19]
Ag production -- SW Cameroon (rainy season)	0.65	
Ag production -- SW Cameroon (dry season)	0.66	
Agriculture -- Rural households in Malawi	0.49	
Total food production, incl. processing, marketing, animal husbandry, and water and fuel supply -- Upper Volta	0.64	McSweeney
Food and cash crop production -- Upper Volta	0.49	
Tanzania 2006, Tanzania Time Use Survey Crop farming (not related to establishments) – Tanzania	0.47	Fontana
Agriculture -- Rajasthan Ages 14-19	0.60	Jain
Agriculture -- Rajasthan Ages 19-34	0.47	
Agriculture -- Rajasthan Ages 34-44	0.36	
Agriculture -- Rajasthan Ages 44-70	0.43	
Agriculture -- West Bengal Ages 14-19	0.34	
Agriculture -- West Bengal Ages 19-34	0.10	
Agriculture -- West Bengal Ages 34-44	0.10	
Agriculture -- West Bengal Ages 44-70	0.02	
Farm hours worked -- China	0.49	De Braw, Li, Liu, Rozelle and Zhang
Agriculture -- Nepal	0.44	Acharya & Bennett

[18] Cited in Charmes, p. 50.

[19] These calculations were made by Charmes, p. 62, based on data from Pasquet and Koppert.

Table 3. Proportion of Total Time in Food Production Contributed by Women

Definition of Activity and Location	Women's Share	Source
Food production, supply and distribution, incl. processing and fuel and water collection, but not cooking – Upper Volta	0.65	McSweeny
Activities related to food preparation -- Tanzania	0.87	Fontana
Ag processing and cooking – Rajasthan Age 14-19	1.00	Jain
Ag processing and cooking -- Rajasthan Age 19-34	0.98	
Ag processing and cooking -- Rajasthan Age 34-44	0.91	
Ag processing and cooking -- Rajasthan Age 44-70	0.90	
Food processing and Cooking—Nepal	0.84	Aharya & Bennett

Table 4. Share of Food produced by Female-headed household.

	% of households headed by women	% of total value of food produced by FHHs
China	3.1	2.1
Bosnia-Herzogovenia	25	13.2
Ghana	33	12
Nicaragua	38	17

Source: Calculated by author from data reported in DeBrauw et al, and from the BiH LSMS survey, the Nicaragua MECOVI survey and Ghana Living Standards Survey.

Table 5. Aggregate Productivity Estimates for Female Share of Agricultural Labor.

	Estimated Relative Productivity of Female Ag Labor	**Share of Effective Labor Units Provided by Women**	
		Weighted	Unweighted
World	1.08	45.6	37.7
Developed countries	0.89	37.5	30.3
Developing countries	1.12	47.3	39.4
Low-income countries	1.26	52.9	58.3
High-income countries	0.89	32.3	27.8
Asia	0.96	41.0	40.2
Latin America & Caribbean	1.42	23.0	22.8
Near East and North Africa	1.19	50.3	38.0
Sub-Saharan Africa	1.14	52.9	53.6

Note: Weighted results adjust for differences in agricultural labor force.

Appendix. Table 1. Agricultural productivity and female share of total population active in agriculture. Developed and developing countries, high and low income countries.

	(1) World	(2) Developed Countries	(3) Developing Countries	(4) High Income Countries	(5) Low Income Countries
Constant	3.838***	4.317***	3.837***	5.036***	3.068***
	(0.110)	(0.189)	(0.127)	(0.185)	(0.203)
Female share of total Agricultural population	**0.0794***	**-0.109***	**0.118***	**-0.113***	**0.259**
	(0.0118)	**(0.0136)**	**(0.0170)**	**(0.0159)**	**(0.102)**
Conventional inputs					
Livestock	0.205***	0.269***	0.200***	0.193***	0.279***
	(0.0118)	(0.0195)	(0.0140)	(0.0223)	(0.0195)
Land	0.647***	0.402***	0.634***	0.511***	0.251***
	(0.0129)	(0.0241)	(0.0193)	(0.0233)	(0.0412)
Tractors	0.0725***	0.0226***	0.0865***	0.0351***	0.0936***
	(0.00416)	(0.00691)	(0.00486)	(0.00549)	(0.00687)
Fertilizer	0.0573***	0.0908***	0.0553***	0.132***	0.0383***
	(0.00318)	(0.00699)	(0.00360)	(0.00719)	(0.00393)
Land quality					
Percent equipped for irrigation	0.0269***	0.0356***	0.0224***	-0.00943	0.0695***
	(0.00602)	(0.00693)	(0.00803)	(0.00845)	(0.00903)
Percent arable land	0.0845***	0.0869**	0.0910***	-0.0122	0.197***
	(0.0222)	(0.0354)	(0.0261)	(0.0378)	(0.0366)
Observations	5305	1447	3858	1294	1806
R-squared	0.804	0.952	0.703	0.947	0.441
Number of countries	154	52	102	37	51
Years	1961-2002	1961-2002	1961-2002	1961-2002	1961-2002

Dependent variable is the log of agricultural output per worker. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All regressions include year dummies and control for country fixed effects.

Appendix Table 2. Agricultural productivity and female share of total population active in agriculture.

	Asia	Near East and North Africa	Sub-Saharan Africa	Latin America
Constant	4.250***	4.649***	2.044***	5.930***
	(0.310)	(0.282)	(0.217)	(0.308)
Female share of total agricultural population	**-0.0438**	**0.422***	**0.191**	**0.137***
	(0.0645)	**(0.0565)**	**(0.122)**	**(0.0218)**
Conventional inputs				
Livestock	0.269***	0.242***	0.231***	0.171***
	(0.0220)	(0.0283)	(0.0213)	(0.0348)
Land	0.277***	0.581***	0.691***	0.251***
	(0.0392)	(0.0399)	(0.0407)	(0.0409)
Tractors	0.0815***	0.173***	0.0510***	0.0289*
	(0.00568)	(0.0218)	(0.00798)	(0.0163)
Fertilizer	0.0658***	0.0234**	0.0164***	0.0883***
	(0.00623)	(0.0102)	(0.00457)	(0.00886)
Land quality				
Percent equipped for irrigation	-0.108***	0.0650*	0.0561***	-0.00392
	(0.0150)	(0.0332)	(0.00978)	(0.0201)
Percent arable land	0.0808	-0.223**	0.406***	-0.0924**
	(0.0683)	(0.0909)	(0.0374)	(0.0433)
Observations	664	499	1504	1106
R-squared	0.873	0.947	0.498	0.673
Number of countries	17	12	43	27
Years	1961-2002	1961-2002	1961-2002	1961-2002

Dependent variable is the log of agricultural output per worker. Standard errors in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. All regressions include year dummies and control for country fixed effects.

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