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Education: a key to women's agricultural productivity in Cambodia

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Abstract

As women comprise a larger share of land managers, it is important to discern factors that limit their success. Using nationally representative data from Cambodia we compare factors associated with productivity among female headed households as opposed to male headed households. OLS regressions show that household size, education, vocational training, land area, an index of non-agricultural capital, and the income share from agriculture are positively related to all types of agricultural revenue. However, when we use a Blinder-Oaxaca decomposition to separately consider revenue from crop production and rice production (as opposed to animal husbandry) we see that after the primacy of land access, the years of education are the next most important, and that differences between endowments explain all of the difference between male and female-headed households. We conclude that there are high returns to investment in education for girls and women in Cambodian agriculture.

JEL codes Q12, J16, J31

Keywords: Cambodia, education, Blinder-Oaxaca decomposition, agricultural productivity, FAO, 50x2030

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Introduction

A lot of factors can limit agricultural productivity (Ali & Deininger 2015), from land quality and quality to labor use to access to technology, but a key problem is the role of male-female differences in technical efficiency. This is increasingly important as in rural areas worldwide, men are increasingly migrating while women take up farm management (Kawarazuka et al 2022). Partly as a result, women constitute 52% of the agricultural labor force in countries like Cambodia (Agarwal 2015); as of 2015, about 8% of the population had left the country to seek work opportunities, and internal migration also takes many workers from rural to urban areas (OECD 2017). While they take a larger role, they face unique challenges: women managers have less access to credit, extension, land, other inputs (Kawarazuka et al. 2022). Agarwal (2015) writes, “To revive and sustain agricultural growth, as well as adapt to or mitigate climate change, the role of women farmers will thus be central.”

Previous research has identified a variety of factors that differentially affect productivity based on gender. Land access is an important in almost all studies, including in Sri Lanka (Fukase et al. 2022) and Nigeria (Oseni et al. 2015). Aguilar et al. (2015) finds that in Ethiopia marital status is associated with productivity, and others note that the number of household members (Sell et al. 2018) and particularly the child dependency ratio (Ali et al. 2016) can be important.

Labor productivity is low due to low levels of skills and training (Bou 2022). Access to inputs and technical help can improve efficiency of land and water use; facilitating improved access to inputs and extension services is key (Ly 2019). While the country has made good progress in expanding access to primary education, quality lags: many children fail to reach benchmarks for literacy, and more than half of students drop out of secondary school (UNICEF 2022). In a study of agricultural workers Cambodians averaged just six years of formal education (Bunthan 2020), and in the current data, women average significantly less.

In this paper we investigate the factors that influence agricultural revenue. A descriptive approach is common in the literature (cf. Quisumbing 1996, Peterman et al. 2011) and has been used to describe the comparative productivity of male vs. female household heads in Nigeria (Bello et al. 2021), Uganda (Ali et al. 2016), Sri Lanka (Fukase et al. 2022), and even the United States (Fisher et al. 2023). Slavchevska (2015) notes that in Tanzania unobservable factors contribute significantly to the gap, and the data will show if that is also true in Cambodia.

Using data collected by the 50x2030 project with funding from the World Bank and FAO, we use a Oaxaca-Blinder decomposition to find out the how gender affects productivity, looking at 1) total agricultural productivity; 2) crop productivity; and 3) productivity considering only rice, the most common crop. The decomposition allows us to distinguish between the portion of the variation in outcomes that can be explained by differences in characteristics such as education and age as opposed to unexplained differences which may be due to unequal treatment.

Data

This study uses the Cambodian Agricultural Survey from 2020, available from the FAO and from 50x2030. Management information, including identity of the manager and the amount of capital and number of labor hours invested in a given plot is not available at the plot level; all data is therefore at the household head level. Table 1 shows our full sample statistics.

Table 1. Full sample statistics

	Mean	SD	Min	Max
Region 1 (Coastal)	0.08		0	1
Region 2 (Plateau & Mountain)	0.15		0	1
Region 3 (Plains, baseline)	0.45		0	1
Region 4 (Tonle Sap)	0.33		0	1
Age*	48.9	12.3	19.5	70
Married	0.86		0	1
Widowed	0.11		0	1
Education (years)	6.0	3.2	0	14
Vocational training	0.13		0	1
Child ratio (children / work age adult)	0.42	0.53	0	6
Household size	4.3	1.5	1	7
Area of land owned (HA)	2.4	4.3	0.001	35
Female head (1=yes)	0.24		0	1
Income share from ag	41%	27	0	100
Non-ag capital index†	0	0.27	-0.2	3.4
Agricultural revenue, log	15.1	1.8	6.6	21.1

N=14078. To protect privacy, age is coded in four groups: 19.5 years (15-24), 34.5 (25-44), 54.5(45-64), or 70 (over 65). †The "non-ag capital index" is created using factor analysis to weigh the number of hectares of land occupied by the home and by all buildings on the property.

In Table 2 we compare households with male and female heads, noting that households with a female head are different in a number of respects. If a household has a female head, we see that:

1) The household will have less agricultural revenue. Of the observations in our data, the 24% of households with female heads average about USD $2100, while households with male heads average about $3700.
2) Land owned is about 40% less (2.7 vs. 1.6 hectares).
3) Household sizes are smaller by about half a person on average (3.88 vs. 4.34); household heads are a bit older on average and are more likely to be widowed.
4) Educational and vocational training are lower.
5) We chose to exclude land tenure (i.e. access to formal title) as when included in any of the following analyses it is not significant, titled percentages do not vary by sex of the household head, and data is not available for about 9% of our sample. In all specifications we DO include the number of hectares of land owned.

Table 2. Sample statistics by sex of household head

	Male	Female	P-value (t or χ^2)
Region 1 (Coastal)	8%	7%	0.40
Region 2 (Plateau & Mountain)	15%	12%	0.00***
Region 3 (Plains, baseline)	43%	53%	0.00***
Region 4 (Tonle Sap)	34%	28%	0.00***
Age*	48.1	51.1	0.00***
Married	97%	53%	0.00***
Widowed	2%	40%	0.00***
Education (years)	6.4	4.8	0.00***
Vocational training	14%	9%	0.00***
Child ratio (children / work age adult)	0.42	0.42	0.70
Household size	4.4	3.9	0.00***
Area of land owned (HA)	2.7	1.5	0.00***
Income share from ag (%)	42	36	0.00***
Non-ag capital index	0.00	-0.02	0.00***
Agricultural revenue, log	15.3	14.7	0.00***
Crop revenue, log	14.5	14.0	0.00***
Rice revenue, log	14.4	14.1	0.00***

N = 14078 for all but crop revenue (N=12337) and rice revenue (N=8051). *** = significant at the 1% level.

While the most common agricultural pursuit is horticulture, Cambodians engage in a variety of agricultural activities, with some raising terrestrial livestock such as cattle, buffalo, pigs, and poultry while others do aquaculture and/ or capture fishery. In Table 3 we look more deeply into agricultural practices by the sex of the household head, noting:

1) The mix of agricultural activities is mostly similar, with women-led households producing less livestock. Bovines (cows & buffalo) & pigs are produced by 18% of male-headed households, but by 15% of female headed households. For poultry the numbers are 29% for male-headed and 30% for female headed households.
2) The mix of crops is also similar.

Table 3. Agricultural practices, male vs. female heads of household

	Male heads	Women heads	χ^2 p-value for difference
No agricultural revenue	5.7%	7.0%	0.00***
Horticulture	88%	87%	0.25
Aquaculture	7%	5%	0.00***
Capture fishery	27%	20%	0.00***
Cattle & pigs (incl buffalo)	42%	37%	0.00***
Poultry	75%	73%	0.02**
Crop: Non-aromatic rice	58%	59%	0.15
Crop: Aromatic rice	14%	12%	0.00***
Crop: Mango	48%	46%	0.09*
Crop: Banana	39%	44%	0.00***
Crop: Coconut	33%	33%	0.55

N for practices = 14078. N for crops = 13727. * = significant at 10% level; ** = significant at 5% level; *** = significant at 1% level.

Tables 2 and 3 show that female-led households are worse off in a number of respects. Interestingly crop production is engaged in by male and female heads of household at similar rates, while animal production and harvesting by households headed by women is less common. One lack in the data is price information on eggs: although chicken are owned by a majority of households, there is almost no data in this year's survey or last year's survey about the price of eggs. We assume that most consumption of eggs is happening at home, and unfortunately the lack of prices means we are unable to estimate the contribution to total revenue associated with them.

Households with female heads produce less revenue than do households with male heads: the main question is the degree to which differences can be explained by different endowments, such as education or land access. The next step is to identify what factors might affect productivity.

Methodology

So far we have looked at the differences between male-headed and female-headed households using descriptive statistics; next we will investigate the differences more thoroughly. Our explanatory variables throughout our analysis include the education of the household head (years), whether the household head has completed any vocational training, the ratio of children to adults in the household, the total number of people in the household, the area of land (log), income share from agriculture, and non-ag capital index. We try to avoid endogeneity by excluding capital used toward agricultural ends such as irrigation and inputs such as pesticides and fertilizers.

Following Ali et al. (2016), we start by using OLS to look at the factors affecting productivity and then do a Blinder-Oaxaca decomposition to see how factors affect productivity differently in households headed by men or women. The first step of the decomposition is to run the regressions on the different subsamples to investigate the degree to which farmer characteristics explained productivity, including factors explaining the gender gap. This lets us identify differences in explanatory variables, though importantly it does not provide causal identification.

Originally developed to analyze the degree to which employment or income depend on tangible skills such as education as opposed to sex or race, the method breaks the gap in earnings into an explained and an unexplained portion. Here, we use this approach to separate differences in endowments (such as land and education) from differences in the returns to endowment. In other words, the method estimates a productivity gap between male and female household heads, and then estimates the degree to which that gap can be explained taking into account only differences in asset endowments. The unexplained contribution is equal to the remaining gap once all included variables are accounted for, and the results show the change in output that would occur if male and female household heads had the same returns to the characteristics included as explanatory variables (Ali et al. 2016).

Some households have no agricultural revenue, and hence no logged agricultural revenue. To control for selection bias, we use Heckman estimation methods, using demographics such as age, age squared, and marital status as instruments.

Results

When we regress total agricultural productivity on having a female head of household, we find that all else equal these households have about 0.59 log units less revenue, an effect that is highly significant. This effect size is equivalent to a move from the median level of revenue to the 36^{th} percentile. We also investigate the effect of adding just provincial fixed effects, but that results in almost no change.

Next we begin including other regressors. Table 4 shows the impact of a variety of factors of production on the logged value of revenue from agricultural sources. The biggest factors are the area of land and the share of income from agriculture, with household size, vocational training, and sex of the household head following.

Table 4. OLS regression results

	Coefficient	t-statistic	p-value
Female household head	-0.14	3.51	0.00***
Education (years)	0.01	1.44	0.15
Vocational training	0.25	5.94	0.00***
Child ratio	-0.06	1.92	0.06*
Household size	0.13	11.58	0.00***
Area of land, log	0.45	23.60	0.00***
Income share from ag	0.01	20.24	0.00***
Non-ag capital index	0.12	2.25	0.02**

N = 13232; R^2 = 0.31. Absolute value of t-statistic shown. Regressions also included age, age^2, and dummy variables for region and marital status (married & widowed) as well as province level fixed effects. *=significant at 10% level; **=significant at 5% level; and *** = significant at 1% level.

Next we move on to the decomposition, with results shown in Table 5. We see that most of the difference between male and female heads of household can be explained using the factors shown. If women are given access to the same factors of production as their male counterparts, the model anticipates that 62% of the difference between the groups would be explained. The t-statistics in the second half of the table show roughly the degree to which the given covariate is associated with revenue. Unsurprisingly the relationship between the amount of land and the number of people available to work the land (i.e. household size) is strong. Also the share of income from agriculture is strongly linked to income: if households are relying predominantly on agriculture for their livelihoods they are more likely to produce agricultural revenue. We see that education and vocational training are important in this analysis, with both characteristics significantly associated with value produced by the household. On the other hand the child ratio, which was one of the most important determinants in Uganda (Ali et al. 2016) is not significant here.

Table 5. Oaxaca decomposition: log (total) revenue

	Coefficient	t-statistic	p-value
Overall: Male heads	15.27	704.9	0.00***
Overall: Female heads	14.66	425.4	0.00***
Difference	0.61	15.11	0.00***
Explained	0.38	15.94	0.00***
Education (years)	0.03	3.79	0.00***
Vocational training	0.01	4.21	0.00***
Child ratio	0.00	0.00	0.19
Household size	0.06	8.83	0.00***
Area of land, log	0.22	12.43	0.00***
Income share from ag	0.07	8.06	0.00***
Non-ag capital index	0.00	2.19	0.00***

N = 13878. Absolute value of t-statistic shown. Region dummies and demographics such as age and marital status also included. *** = significant at 1% level.

When we consider only determinants of crop revenue, we are able to explain a larger share- 99%- of the difference between male and female household heads. The importance of education is clearer here, with an additional year of education associated with an increase of 0.04 log points, which is 8% of the difference in productivity between male and female household heads. Access to land and the income share from agriculture continue to show a strong relationship with revenue. The impact of vocational training has dropped in magnitude and significance, and the impact of an additional household member is also small.

Table 6. Oaxaca decomposition: log (crop) revenue

	Coefficient	t-statistic	p-value
Overall: Male heads	14.53	714.54	0.00***
Overall: Female heads	14.04	441.65	0.00***
Difference	0.49	13.06	0.00***
Explained	0.49	16.47	0.00***
Education (years)	0.04	7.12	0.00***
Vocational training	0.003	1.61	0.11
Child ratio	0.0001	0.11	0.91
Household size	0.0001	0.05	0.96
Area of land, log	0.45	16.45	0.00***
Income share from ag	0.03	7.28	0.00***
Non-ag capital index	0.003	2.57	0.01**

N = 13636. Absolute value of t-statistic shown. Region dummies and demographics such as age and marital status also included. *** = significant at 1% level.

Table 7 shows the decomposition of factors affecting revenue from rice production. As expected the total amount of revenue generated has gone down for both households with male and female heads. Here we see that if women are given access to the same factors of production as their male counterparts, the model anticipates that more than 100% of the difference between the groups would be explained. Also in this decomposition we see that education has become the second clearest predictor of agricultural revenue, behind only land.

Table 7. Oaxaca decomposition: log (rice) revenue

	Coefficient	t-statistic	p-value
Overall: Male heads	14.33	328.47	0.00***
Overall: Female heads	14.07	487.37	0.00***
Difference	0.26	4.99	0.00***
Explained	0.32	13.78	0.00***
Education (years)	0.05	8.44	0.00***
Vocational training	0.001	0.65	0.52
Child ratio	-0.002	1.05	0.30
Household size	0.01	2.30	0.02**
Area of land, log	0.29	13.85	0.00***
Income share from ag	0.01	4.42	0.00***
Non-ag capital index	0.001	0.93	0.35

N = 12898. Absolute value of t-statistic shown. Region dummies and demographics such as age and marital status also included. *** = significant at 1% level.

Conclusion

"Producing more food from available land, water and human resources… is essential… to… ensure food security, especially relevant for the rural poor" (Mishra 2021).

Using nationally representative data from Cambodia, where women are more than half of the agricultural labor force, we use a Blinder-Oaxaca decomposition to compare factors associated with productivity among female headed households as opposed to male headed households.

Our data exercise investigates the links between land access, education, and household size vis-à-vis agricultural revenue from different sources. Unsurprisingly female heads of household appear much less productive than those headed by a male. We note that female heads of household are different in a number of respects from households with male heads, including less land and education, a greater likelihood of having been widowed, and fewer members of the household. Also our methodology allows us to describe the factors contributing to production but we cannot claim a causal linkage between any of the factors included and revenue.

OLS regressions show that household size, education, vocational training, land area, an index of non-agricultural capital, and the income share from agriculture are positively related to all types of agricultural revenue. When we separately consider revenue from crop production (as opposed to animal husbandry) we see that after the primacy of land access, the income share from agriculture and years of education are the next most important. Finally when we consider revenue from rice production we find that after land access education alone is the most important, with t-scores over 8. We conclude that there are high returns to investment in education for girls and women in Cambodian agriculture.

That said, this descriptive exercise allows us to draw a number of conclusions. First, for overall agricultural revenue, much of the difference is explained by observable factors such as access to non-agricultural streams of income, access to land, and having fewer household members. Second, the most important factors predicting crop and rice revenue are land and education. Third, factors shown important in other studies such as the number of household members and child dependency ratio (Ali et al. 2016, Sell et al. 2018) seem to matter less than education in a Cambodian context.

This calls to mind the recommendation by UNICEF (2022) that for women's success, it is crucial to improve the quality of and access to education. For example, a 2019 survey found that participation in agricultural cooperatives improved sustainability and profitability of farms, increases that were correlated with higher levels of education completed (Bunthan 2020). Making this information available may prompt policymakers and ultimately households to invest more in education.

Also while vocational training was not always significant, it was highly significant in the first decomposition (in Table 5). Maybe types of training other than horticultural training make more of a difference. While research on the global level shows that agricultural programs have only mixed effects on food consumption (Gitter et al. 2022), there is clearly room for growth in Cambodia. The Helen Keller Institute created a program that enhanced household food production improving child health, and the potential for scalability is strong (Dragojlovic et al. 2020). Another study used a randomized control trial to investigate a home garden intervention, finding significant impacts on amounts harvested and length of the growing/ harvesting season (Depenbusch et al. 2022). Finally, irrigation can greatly improve productivity of Cambodian rice fields and thereby ameliorate food insecurity among agricultural households (Resosudarmo & Chheng 2021). (Note that some of these trials were not carefully controlled, so evidence is only suggestive.)

Finally, a few caveats. Quisumbing (1996) notes that using profits is preferred to revenues to avoid endogeneity, but our data provides only limited information on investments in production, including costs, so the focus of our study is revenue. Further, it would be better if the identity of the manager was listed by plot, but that level of information is not available. Instead we are forced to rely on a female head of household variable, a known problem (Quisumbing & Doss 2021). We can only hope that subsequent rounds of data will provide more detail for us to attempt a deeper analysis.

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