Necessary but Not Sufficient: The Limitations of Empowerment Metrics in Predicting Agricultural Productivity

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Job Market Paper, 2025

JEL: D24, J16, D63

Keywords: Agricultural Productivity, Agricultural Value Chains, Gender Productivity Gaps, Empowerment, Stochastic Production Frontier, Technical Efficiency

Abstract

Agricultural value chains are shaped not only by production technologies but also by the social and institutional environments in which producers operate. Using survey data from rice farmers in Cambodia, this paper examines whether current indicators of personal agency and autonomy effectively capture agricultural productivity within value chains. I apply stochastic production frontier models to assess whether empowerment metrics improve the explanation of productivity outcomes. Results show that these measures do not consistently predict productivity, suggesting that structural and socially embedded constraints, such as market access, value chain coordination, and resilience to shocks, play a more substantial role. These findings highlight limitations of existing productivity measurement and underscore the need for more context-relevant indicators of agricultural performance. For stakeholders, the results suggest that extension and development initiatives should prioritize people-centered partnerships that enhance accessibility within supply chains and strengthen the resilience of local enterprises, thereby supporting more equitable and sustainable growth.

1 Introduction

In contemporary discussions on gender productivity gaps, differences in productivity between women and men are almost exclusively studied in contexts where women are both less empowered and less productive. As a result, prevailing theories regarding gender productivity gaps and their causes are shaped by this specific setting. One such theory suggests that increases in empowerment, measured through productive time use, decision-making power, control over resources, group membership, and participation in various types of work, are associated with higher productivity (Kabeer, 1999; Mosedale, 2005; Alkire et al., 2013; Diiro et al., 2018; Raghunathan et al., 2019; Kumar et al., 2021; Myers et al., 2023; Quisumbing et al., 2023). However, evidence supporting this relationship comes primarily from studies within limited and similar contexts (Seymour, 2017; Diiro et al., 2018; Clement et al., 2019; Wouterse, 2019; Anik & Rahman, 2021).

By leveraging a unique empirical setting: a sample of rice farmers in Cambodia where there is no observed gender yield or empowerment gap, this paper tests the robustness of previous findings by examining whether empowerment maintains a positive relationship with productivity when women are not disadvantaged, and whether empowerment can explain the absence of gender productivity gaps in this context.

To do so, I employ a novel econometric method, using a transcendental logarithmic (translog) stochastic production frontier model that disentangles empowerment's role in technical efficiency, offering a richer econometric approach than those employed in previous studies. I also decompose empowerment into its component dimensions rather than relying solely on an indexed value, allowing for identification of which dimensions matter more or less for productivity. Additionally, I estimate models separately for male and female farmers, highlighting potential effects of heterogeneity that are lost in pooled analyses. This approach allows for a detailed estimation of both the marginal effects of inputs on production and the technical efficiency with which inputs are used, building upon approaches used in prior gender and productivity studies (Seymour, 2017; Julien et al., 2023; Diiro et al., 2018; Clement et al., 2019; Anik & Rahman, 2021).

I find that for all samples, adding empowerment metrics does not meaningfully alter the estimated impact of inputs on productivity and these metrics do not consistently show the expected sign or relationship with technical efficiency. Further, across all specifications, there is no statistically significant difference in technical efficiency between women and men. However, I find that the female subsample is more sensitive to the inclusion of empowerment metrics than either the full sample or the male subsample. In exploring potential mechanisms behind this sensitivity, I find that the

nexus of input access and empowerment is more influential for women than men. This suggests the existence of unmeasured gendered confounding factors around input access and empowerment likely influence women's agricultural productivity.

These findings therefore make four contributions to literature on agricultural productivity and gender productivity gaps. First, I introduce a novel econometric approach in testing the efficacy of existing metrics' predictive power on agriculture productivity. Second, I establish that a significant, positive relationship between empowerment and productivity is not a reliable theoretical or empirical assumption. Third, I demonstrate that pooled results on productivity can often mask important heterogeneous effects between groups. Fourth, I provide evidence that the measurement of sociocultural and institutional factors is important to our understanding of agricultural productivity, but that current metrics are not capturing the full nuances of those factors.

Therefore, research, policy, and extension programming aimed at expanding agricultural value chain growth through empowerment should not solely rely on existing metrics and previously studied contexts. Instead, researchers should determine which dimensions of existing metrics are most robust, and also work to construct and implement new metrics that better capture how societal constraints may impact agricultural productivity. Policymakers and designers of intervention and extension programming should also incorporate these nuances into their work by first learning about the social and institutional context in which they are operating through stakeholders' perspectives, and then formulating tailored solutions that will address any existing societal barriers to agricultural productivity.

The remainder of the paper proceeds as follows. Section 2 describes the dataset and study setting. Section 3 presents descriptive results. Section 4 outlines the empirical strategy. Section 5 reports production frontier results, while Section 6 explores potential mechanisms and robustness checks. Section 7 concludes with implications for research and policy.

2 Data

The dataset used for this paper was collected as part of USAID's Feed the Future Initiative, Helping Address Rural Vulnerabilities and Ecosystem Stability (HARVEST), in Cambodia. The HARVEST project spanned across four provinces of Cambodia: Battambang, Kampong Thom, Pursat, and Siem Reap (Benfica, 2013; Maredia et al., 2017). At baseline, this study collected information on both plot-level productivity and inputs. It also employed the International Food Policy Research Institute's (IFPRI's)

Women's Empowerment in Agriculture Index (WEAI) questionnaire to capture the empowerment levels of the participants (Alkire et al., 2013). Modules included in the empowerment section assessed individuals' asset ownership, access to credit, time use, and role in decision-making on productivity-related activities. Baseline data showed that the female farmers in the sample are slightly more empowered and that there is no significant empowerment or gender parity gap (Benfica, 2013).

One caveat of this dataset is that, given the lack of an empowerment gap that would have been addressed through the intervention, the empowerment modules were only employed at baseline. Further, plot-level data with managerial characteristics was only collected at endline, in 2016. Thus, for the analysis of this paper, I combined the empowerment data with the plot-level endline data, potentially resulting in bias if the intervention of HARVEST influenced either productivity or empowerment. However, the intervention of HARVEST focused on helping farmers transform their plots to grow more nutritionally dense crops. There were no aspects of this intervention that were related to empowerment. Thus, to alleviate any concerns, only plots that were used for rice cultivation were included in this analysis.[1] Moreover, any plots that were not used for rice cultivation in 2012 and 2016 were excluded. The production of these plots in both years is also analyzed, where the t-test statistics show no significant difference in production or productivity over time.

This culminates in a cross-sectional dataset with a sample of 1,159 plot-level observations across 495 households and 509 individual farmers. Each plot had a household member assigned as the manager, and their demographic characteristics were reported in the household roster. Of the 1,159 plots, 804 were managed by a male farmer and 355 were managed by a female farmer. There were 340 individual male farmers and 169 female farmers. Additionally, data on temperature and rainfall at the province level was obtained from a research report that analyzed data from the Department of Meteorology in Cambodia (Shanmugasundaram, et al., 2020).

[1] To account for potential selection bias where an unproductive female rice farmer may have been more incentivized to switch crops, I used a two-tailed test statistic to compare the yields of female farmers who grew rice in both 2012 and 2016 to the yields of female farmers who only grew rice in 2012 and were thus dropped from the sample. The average yield for the latter set of farmers was 2,067.009 kg per hectare with a standard deviation of 1,388.552. This average was not statistically significantly different than the average of the female farmers included in the sample. Hence, there is no evidence that only the female farmers who were the most productive rice farmers remained with that crop while other female farmers switched to the nutritious food crops.

2.1 Setting: Rice Farming and Empowerment in Rural Cambodia

Rice production is the backbone of rural livelihoods in Cambodia, where more than two-thirds of the population relies on agriculture for subsistence and income (SCW, 2006, MAFF, 2011). Smallholder farmers cultivate rice under conditions of high seasonal variability in rainfall, limited access to inputs, and reliance on family labor (Touch et al., 2023; Kassam et al., 2011). Within this system, gender roles have been shaped not only by agricultural practices but also by the country's recent history.

The Khmer Rouge regime (1975–1979) and subsequent genocide had profound demographic and social consequences. With large-scale male mortality, women assumed central roles in agricultural production, household survival, and community rebuilding during the post-conflict period. This legacy reshaped gender relations in rural areas, leading to relatively high female labor force participation and unusually strong female roles in household and farm decision-making compared to many other developing country contexts (Gaikwad et al., 2023). Therefore, it is not surprising that female farmers reported empowerment levels comparable to or greater than men in the HARVEST study.

This historical trajectory makes Cambodia a unique empirical setting. Unlike Sub-Saharan Africa, where much of the gender-productivity literature is based, Cambodian female farmers are not systematically disadvantaged in empowerment or productivity. Studying this setting allows for a rare test of whether empowerment metrics universally predict agricultural productivity, or whether their explanatory power depends on contexts where women face structural barriers.

3 Descriptive Statistics

Table 1 presents the descriptive statistics for the productive inputs and output of wet rice farmers as well as managerial variables, including empowerment metrics. In the last three columns of this table, the means by gender for each variable are shown as well as the corresponding two-tailed test statistic. As can be seen, the male respondents had significantly more land as well as higher rates of improved seed, basal fertilizer, and pesticide use. Figure 1 shows the distribution of plot size by gender, where the distribution of plot size is clustered between zero and one for most farmers. Additionally, males had significantly higher output, with male farmers producing approximately 17% more rice than female farmers. Yield (output of rice (kg) per hectare of land), however, is not significantly different between male and female farmers.

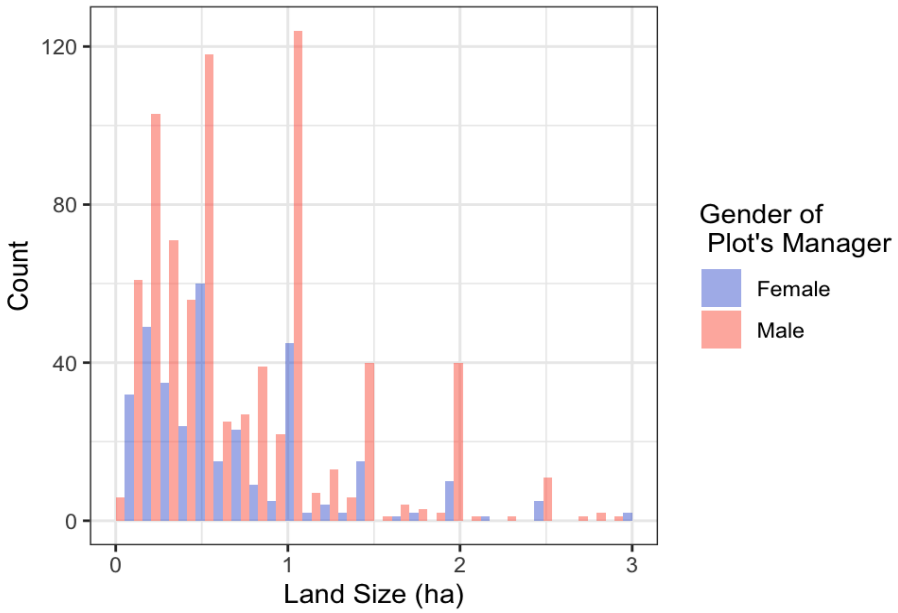


Fig. 1: Distribution of Land Size by Plots (N=1,1159)

Notes: Limit of land size set to 3 hectares for clear visualization (16 plots dropped). Plots managed by female managers are shaded blue, while those managed by male farmers are shaded red.

In relation to empowerment, female farmers had significantly higher rates of ownership over productive assets, input on income made through productive activities, and access to and control over credit. Conversely, male farmers had significantly higher rates of participation in productive activities. In conjunction with the findings of the HARVEST study (Benfica, 2013), where the WEAI score indicated no empowerment gap, these descriptive statistics signify that the female farmers were generally as empowered as their male counterparts (see Appendix A.2 for an explanation on how the WEAI score is calculated). Altogether, these statistics reflect a unique context where female farmers were more empowered on aspects of farming that instigate production - the assets and capital. However, the male farmers were predominantly involved in the management and access of productive inputs. Thus, this context offers a novel opportunity to measure differences in production when there is no productivity or empowerment gap.

Table 1
Descriptive statistics for 1,159 plots and the corresponding 509 Managers

Variable	Obs.	Mean	Std.	Mean (Women)	Std. (Women)	Mean (Men)	Std. (Men)	*p*-val Diff
Agricultural Parameters (Plot-Level)				N =355		N=804		
Harvested Land Area (ha)	1,159	0.777	0.766	0.718	0.703	0.806	0.828	0.031**
Quantity of Improved Seed (kg)	1,159	95.319	107.528	82.277	93.721	101.077	112.664	0.006***
Quantity of Top-Dressing Fertilizer (kg)	1,159	26.920	48.413	23.219	38.82	28.554	52.027	0.084*
Quantity of Basal Fertilizer (kg)	1,159	50.559	89.328	45.762	77.335	52.678	94.106	0.225
Quantity of Pesticide (kg)	1,159	0.455	1.213	0.363	0.839	0.5	1.3	0.089*
Number of Hired Laborers	1,159	12.783	12.900	11.865	11.148	13.19	13.589	0.107
Wet Rice Harvested (kg)	1,159	1513.098	1973.320	1,320.24	1,499.39	1,585.37	2,145.22	0.032**
Yield (kg/ha)	1,159	1983.544	1104.392	2,022.92	1,192.49	1,959.96	1,066.92	0.34
Manager Level Statistics				N=340		N=169		
Age	509	2120.552	1019.609	44.189	10.895	44.641	12.047	0.681
Literacy Score [b]	509	3.567	0.877	3.314	1.059	3.674	0.746	0****
Highest Grade Completed (in years)	509	5.532	3.551	5	3.833	5.994	3.753	0.005***
Number of Plots Managed	509	4.031	2.471	3	1.943	3.176	2.206	0.377
Own Plot (Tenancy Status) [a]	509	0.892	0.250	0.901	0.243	0.887	0.254	0.564
Received Extension Services for Practice [c]								
Irrigation	509	1.851	0.357	1.87	0.337	1.841	0.366	0.394
Organic residue management	509	1.735	0.486	1.775	0.419	1.715	0.452	0.146
Disease and pest control	509	1.619	0.486	1.657	0.476	1.6	0.491	0.215
Percent of Other Extension Services Received	509	0.252	0.243	0.225	0.225	0.266	0.251	0.078*
Empowerment Metrics								
Total Productive Activities that the Manager Participates in	509	4.024	0.974	3.858	1.037	4.106	0.932	0.007***
Level of Input in Productive Activities	509	3.677	0.730	3.687	0.790	3.672	0.700	0.831
Level of Input on Income Use	509	3.551	0.874	4.065	0.714	3.295	0.833	0****
Percent of Assets Self-Owned	509	0.136	0.230	0.228	0.308	0.091	0.162	0****
Access to Credit [d]	509	1.108	1.111	1.42	1.370	0.953	0.921	0****
Control over Credit [e]	509	1.043	1.034	1.385	1.350	0.874	0.782	0****
Total Groups the Manager is Highly Active in	509	2.532	1.422	2.515	1.472	2.541	1.398	0.844
Prevalence of Manager Having Input into All Group Decisions	509	0.466	0.969	0.426	0.980	0.485	0.964	0.516
Total Household Decisions that the Manager has High Extent of Influence	509	0.405	0.967	0.426	1.050	0.394	0.924	0.726
Time Use in Hours [f]								
Hours Spent Farming or Fishing	509	10.625	7.599	8.367	6.804	11.747	7.732	0****
Hours Spent on Personal Care	509	1.806	0.808	1.734	0.798	1.841	0.812	0.158
Hours Spent Cooking	509	1.118	1.828	2.876	2.076	0.244	0.750	0****
Hours Spent caring for Children or the Elderly	509	0.994	3.463	1.988	4.796	0.5	2.416	0****
Hours Spent Sleeping or Resting	509	20.409	4.773	20.213	4.176	20.506	5.047	0.515
Average of Frequency that the Manager makes decisions because [g]								
they fear they will get in trouble	509	1.439	0.580	1.378	0.560	1.469	0.588	0.093
how others will view their actions	509	1.563	0.663	1.607	0.697	1.542	0.646	0.295
they feel it is the right thing to do	509	3.837	0.298	3.829	0.303	3.84	0.296	0.699

Notes: [a] Binary Variable where 0 is "No" and 1 is "Yes"; [b] Index where 1 is cannot read or write, 2 is can sign only, 3 is can read only, and 4 is can read and write; [c] Binary variable where 1 is "Yes" and 2 is "No"; [d] Index where 0 is no access, 1 is little access, 2 is some access, 3 is high access, and 4 is full access; e Index where 0 is no control, 1 is little control, 2 is some control, 3 is high control, and 4 is full control; [f] Hours are reported based on respondent recall for activity out of last 48 hours; [g] Index where 1 is never true, 2 is not very true, 3 is somewhat true, and 4 is always true. Detailed explanations of how each empowerment metric was calculated can be found in Appendix Table A.1.

4 Empirical Strategy

4.1 Empirical Model

This paper utilizes a stochastic production frontier model (Aigner et al., 1977; Kumbhakar and Lovell, 2000) to estimate the effect of farmers' technical efficiency on the production of rice. This approach allows for the separation of the effect of inputs on production from the effect of a farmer's efficiency on production. This separation makes it possible to discern whether the lack of a productivity gap in the sample can be attributed to empowerment through efficiency.

Further, I employ a modified version of the model used in Sherlund et al. (2002), where the stochastic production frontier model is run with different specifications to gauge the statistical relevance of an added set of variables. Equation 1 presents the first of these specifications in log-linear Cobb-Douglas form, where the set of managerial variables is restricted to individual-level metrics that are not included in the empowerment module of the dataset[2]:

$$\ln(y_{pi}) = \beta \boldsymbol{X}_{pi} - u_{pi} + v_{pi}$$

$$u_{pi} = \theta_{pi} M_{pi} + \epsilon_{pi} \qquad (1)$$

where y_{pi} is the output of rice, $\boldsymbol{X}_{pi}$ is a vector of logarithmic inputs, β is a vector of parameters to be estimated, v_{pi} is a random variable, and u_{pi} is a non-negative random variable representing technical inefficiency for individual $\boldsymbol{i}$ and plot $\boldsymbol{p}$ (Battese and Coelli, 1995). Following Sherlund et al (2002), u_{pi} is further defined such that technical inefficiency is related to the managerial variables, $\boldsymbol{M}_{pi}$, with θ_{pi} being a parameter to be estimated and the statistical error term, ϵ_{pi}. This approach controls for the effects heterogeneity among the managerial variables may have on technical inefficiency. The sum of v_{pi} and u_{pi} represents a dual error term, and v_{pi} itself represents statistical noise. Based on specifications outlined in Caudill et al. (1995), it is assumed that u_{pi} has a half-normal distribution where its variance is a function of the sources of technical

[2] These managerial-level metrics consist of controls for age, literacy, education, number of plots managed, tenancy status, and the receipt of extension services for irrigation, organic residue management, disease and pest control, and the percent of other extension services received.

efficiency, $\sigma_{u_{pi}} = \exp(\theta_{pi} M_{pi} + \epsilon_{pi})$. In turn, technical efficiency within the model can be estimated as (Jondrow et al., 1982; Greene, 2008):

$$Technical\ Efficiency_{pi} = \exp(-u_{pi})$$

The parameters for the stochastic production frontier and technical efficiency are then estimated via maximum likelihood estimation. The second specification of the model is shown in Equation 2, where the key difference is the makeup of the vector for managerial variables. In this model, it is implied that empowerment influences productivity through efficiency. Such an approach has been used in previous studies on empowerment and technical efficiency (Seymour, 2017; Diiro et al., 2018; Ruel et al. 2018; Wouterse, 2019; Seymour et al., 2019; Anik and Rahman, 2021). In Equation 2, all variables are the same as in Equation 1, except for in M^*_{pi}, which is now augmented with variables on empowerment (see Appendix Table A.1 for a list of added empowerment metrics), including quantity of self-owned assets, access to and control of line of credit, control over resources, input in decision-making processes, participation in group activities, and time use.[3]

$$\begin{aligned} Y_{pi} &= F(X_{pi}) - u^*_{pi} + v^*_{pi} \\ u^*_{pi} &= \theta^*_{pi} M^*_{pi} + \epsilon^*_{pi} \end{aligned} \qquad (2)$$

This strategy controls for the effect heterogeneity in empowerment may have on technical efficiency. Further, it allows for the comparison of estimates of the stochastic production frontier and technical efficiency when empowerment metrics are included versus when they are not. If there are significant changes in the estimates of technical efficiency and the effects of inputs on outputs after the empowerment metrics are added, then there is evidence that empowerment and productivity are correlated in the context of this dataset. If the findings of previous literature hold, that increased empowerment leads to higher productivity, this would further suggest that empowerment was a factor in equitable productivity between female and male farmers.

[3] These empowerment metrics were chosen based on the modules used in the HARVEST survey. Instead of calculating the WEAI, each sub-module of the WEAI module (i.e. asset ownership) was collapsed to a singular metric. Thus, in the added set, there is at least one metric per-sub module.

4.2 Empirical Specification

To estimate the stochastic production frontier and technical efficiency, two common functional forms are the logarithmic Cobb-Douglas, as presented above, or the transcendental logarithmic (translog) form that includes logged variables as well as second-order terms for the input variables to allow for possible non-linear relationships between these variables and the output variables (Meeusen & van Den Broeck, 1977; Lee & Tyler, 1977; Coelli et al., 2005; Greene, 2008). After applying each of these specifications and running joint hypothesis testing, I found the translog specification to be the most appropriate functional form for this analysis.[4] Many studies have utilized this method including several in the field of agricultural economics (Sherlund et al., 2002; Ayinde et al., 2009; Mensah et al., 2016; Silva et al., 2017). The translog production function for the more restricted model that does not include empowerment metrics is then as follows:

$$\ln(Y_{pi}) = \beta_0 + \sum_{k=1}^{K} \beta_k \ln(X_{pi}) + \frac{1}{2}\sum_{k=1}^{K}\sum_{j=1}^{K} \gamma_{jk} \ln(X_{pji}) \ln(X_{pki}) - u_{pi} + v_{pi}$$

$$u_{pi} = \theta_{pi} M_{pi} + \epsilon_{pi} \tag{3}$$

In this model, Y_{pi} is plot-level output of rice in the wet season in kilograms, X_{pi} is a vector of inputs including land, fertilizer, labor, pesticide, and seed, and v_{pi} and u_{pi} are the random variables for individual $\boldsymbol{i}$ and plot $\boldsymbol{p}$, where β_0, β_k, γ_{jk} $(j, k = 1, \ldots., K)$, and θ_{pi} are parameters to be estimated.[5] Average province-level temperature (C°) and

[4] Tests run were the log-likelihood ratio test, Wald test statistic, and Bayesian information criterion. Each of these indicated the translog model was the most appropriate fit for the data and analysis. See Appendix Tables A.3a-A.3c for Cobb-Douglas results.

[5] There were plots where no fertilizer or pesticide was used, meaning some observations had a value of zero that could not then be transformed into a logarithmic form. I attempted to circumvent this issue by first performing the analysis with only plots that used all inputs. However, this limited the sub-sample of female farmers to the extent where the translog model would not converge due to the small sample size. Therefore, I employed the approach taken in Sherlund et al (2002), where I set $\ln(0) = \ln(\zeta/10)$ where ζ is the smallest in magnitude strictly positive observation in the sample. This approach is more appropriate for the dataset than the approach of Battese and Coelli (1995) where $\ln(0) = 0$ given that many observations were between the values of 0 and 1.

rainfall (mm) are included as control variables.[6] To account for heterogeneity between plot managers, u_{pi} is defined such that M_i represents managerial variables including age, literacy, education, sex, number of plots cultivated, a control for plots being managed by the same manager, and receipt of extension services related to soil quality.[7]

The translog specification for the model that includes the empowerment metrics is thus:

$$\ln(Y_{pi}) = \beta_0^* + \sum_{k=1}^{K} \beta_k^* \ln(X_{pi}) + \frac{1}{2}\sum_{k=1}^{K}\sum_{j=1}^{K} \gamma_{jk}^* \ln(X_{pji}) \ln(X_{pki}) - u_{pi}^* + v_{pi}^*$$

$$u_{pi}^* = \theta_{pi}^* M_{pi}^* + \epsilon_{pi}^* \quad (4)$$

where β_0^*, β_k^*, γ_{jk}^* $(j, k = 1, \ldots, K)$, and θ_{pi}^* are parameters to be estimated. The models were run under three different contexts: for the full sample, for only the male farmers, and only the female farmers. This was done in order to compare the effect of including empowerment metrics between female and male farmers. The full sample is also included to show this relationship within the overall sample and to emulate previous studies (Seymour, 2017; Diiro et al., 2018; Clement et al., 2019; Wouterse, 2019; Anik & Rahman, 2021). By doing so, it is also possible to capture any nuances previous literature may have missed if empowerment does not behave similarly between women and men.

[6] Average province level temperature and rainfall were the most precise measurements available, reported by the World Bank Group (2024) and are reflective of findings in existing literature (Thoen et al., 2015; Botkosal et al., 2012).

[7] Due to there being a small number of individuals living in the same household, a control for being in the same household was heavily correlated with the control for plots being managed by the same manager. This resulted in issues of multicollinearity when both metrics were included. The models were run with either metric, with no significant difference between the results. Thus, the estimates reported here were generated using only the control for plots being managed by the same manager.

5 Results

If empowerment were universally linked to agricultural productivity, we would expect empowerment metrics to improve the fit of production models, raise technical efficiency, and explain productivity across gendered subsamples. The results, however, do not support this expectation.

5.1 Stochastic Production Frontier

Table 2 presents the stochastic frontier estimates of each input for the full sample and by gender (full results reported in Appendix Table A.4). Asymptotic standard errors are used here to allow for the log-likelihood ratio test.[8] In the full sample, empowerment metrics do not materially affect the magnitude, sign, or significance of core inputs such as land, labor, and fertilizer. The likelihood ratio test indicates statistical differences between restricted and expanded specifications, but the BIC favors the restricted model, suggesting empowerment does not add justified explanatory power.[9] Results for men closely mirror the full sample, with some slight changes in significance but empowerment having no substantial impact on input coefficients.

By contrast, results for women are somewhat more sensitive to the inclusion of empowerment variables. The significance of rainfall disappears, and some input interactions become newly significant, though again, the restricted model remains favored by model selection criteria. Thus, there is evidence that the relationship between empowerment and production, whether adding sufficient improvement or not, behaved differently between female and male farmers. Overall, empowerment metrics appear to affect women's production outcomes more than men's, but inconsistently and not in ways that align with theoretical expectations. in goodness of fit that justifies the increased complexity of the model. In all, these findings suggest that empowerment was not influencing production through technical efficiency to a degree that justifies their inclusion.

[8] For robustness checks including robust standard errors and clustered standard errors at the commune level, see Appendix Tables A.5-A.6.

[9] The log-likelihood ratio test statistic is used here as it provides insight between the goodness of fit for the more restricted model (the model without empowerment metrics) and the fuller model (the model with empowerment metrics). The BIC is used as it tests whether this goodness of fit is essentially worth the complexity created in the model when additional variables are added. Schwarz's BIC is considered over Akaike's information criterion since the model for this paper is primarily focused on explanatory power, for which the BIC is consistent (Shmueli, 2010).

Table 2

Stochastic Production Frontier Estimates for Inputs of Harvested Rice

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096****	1.192****	1.140***	1.303****	1.502**	1.589**
	(0.323)	(0.328)	(0.387)	(0.390)	(0.627)	(0.630)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.089	0.078	-0.055	-0.655	-0.921
	(0.308)	(0.315)	(0.363)	(0.369)	(0.592)	(0.591)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.003	0.002	-0.004	-0.008	-0.003
	(0.012)	(0.012)	(0.014)	(0.014)	(0.024)	(0.024)
Quantity of Top-Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.048****	0.077***	0.079***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.025)	(0.026)
Quantity of Pesticide (Pest) (kg)	0.043	0.044	0.067**	0.054	0.008	0.079
	(0.028)	(0.028)	(0.033)	(0.033)	(0.056)	(0.056)
Number of Hired Laborers (Labor)	-0.252****	-0.261****	-0.217***	-0.209***	-0.327***	-0.377***
	(0.058)	(0.059)	(0.067)	(0.066)	(0.121)	(0.120)
Constant	-1.175	-1.031	-1.542	-1.486	-3.453	2.915
	(2.197)	(2.219)	(2.716)	(2.713)	(4.034)	(4.093)
σ_v^2	0.275	0.281	0.263	0.274	0.288	0.375
	(0.018)	(0.018)	(0.020)	(0.021)	(0.033)	(0.016)
N (plots)	1,159	1,159	804	804	355	355
Log-Likelihood	-766.154	-756.277	-533.284	-517.293	-206.473	-184.617
Bayesian Information Criterion (BIC)	1807.466	1907.651	1320.77	1402.514	636.086	692.201
Wald $\chi^2(22)$	4004.06****	3879.77****	2867.77****	2798.46****	1512.35****	1491.90****
Log-Likelihood Ratio Test Statistic	19.76		31.98**		43.17****	

Notes: a. Province level; All six inputs are in logarithmic form, including for squared and interaction terms. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

5.2 Marginal Output Elasticities at the Mean

The output elasticities reported in Table 3 further reinforce these findings.[10] Land and labor exhibit significant negative elasticities, consistent with diminishing returns, while fertilizer elasticities are positive across all specifications. The inclusion of empowerment metrics does not significantly alter these elasticities for the full or male subsample. For women, some elasticities shift slightly, but overlapping confidence intervals indicate that these differences are not statistically meaningful. This overlap indicates that the observed changes in coefficient values could be due to random variation, and thus, it cannot be conclusively said that the coefficients in the models with empowerment metrics differ from those in the original models. Thus, there is further evidence that empowerment, as currently measured, has little impact on how inputs are transformed into output.

Table 3
Marginal Elasticities of Inputs at the Mean

Input	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Land Area (ha)	-0.0948****	-0.103****	-0.0901***	-0.103****	-0.156**	-0.173**
	(0.0279)	(0.0284)	(0.0306)	(0.0309)	(0.0652)	(0.0684)
Quantity of Improved Seed (kg)	0.0031	-0.0500	0.0444	-0.0311	-0.3600	-0.5270
	(0.1730)	(0.1770)	(0.2060)	(0.2100)	(0.3250)	(0.3390)
Quantity of Basal Fertilizer (kg)	-0.0006	-0.0004	-0.0002	0.0004	0.0016	0.0006
	(0.0017)	(0.0017)	(0.0016)	(0.0016)	(0.0052)	(0.0054)
Quantity of Top Dressing Fertilizer (kg)	0.0020****	0.0020****	0.0016****	0.0014****	0.0028***	0.0030***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0009)	(0.0010)
Quantity of Pesticide (kg)	-0.0246	-0.0256	-0.0379**	-0.0303	-0.0047	-0.0511
	(0.0163)	(0.0163)	(0.0187)	(0.0186)	(0.0350)	(0.0364)
Number of Hired Laborers	-0.0714****	-0.0741****	-0.0617***	-0.0595***	-0.0926***	-0.1110***
	(0.0165)	(0.0166)	(0.0191)	(0.0189)	(0.0344)	(0.0353)
N (plots)	1,159	1,159	804	804	355	355

Notes: Estimates are rounded to the ten-thousandths. Asymptotic standard errors are in parentheses. p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

[10] For robust and clustered marginal effect estimates, see Appendix Tables A.7-A.8.

5.3 Technical Efficiency

Table 4 reports the empowerment-related coefficient estimates on technical efficiency (full results presented in Appendix Table A.9).[11] [12] Here, the coefficients reflect the impact on technical efficiency, where a negative coefficient suggests a variable decreases inefficiency, thereby enhancing efficiency (Battese & Coelli, 1995; Greene, 2008). Consistent with prior literature, significant variables are expected to demonstrate that increased empowerment leads to greater efficiency. Contrastingly, these findings show that empowerment metrics explain little variation in efficiency in the full sample, and in some cases have counterintuitive effects: greater asset ownership and more time spent on personal care are associated with lower efficiency. Based on existing theory, it is expected that higher levels of both these variables induce higher empowerment, and thus, the estimates of this model suggest that higher empowerment paradoxically results in lower efficiency (Kabeer, 1999; Alkire et al., 2013; Myers et al., 2023; Quisumbing et al., 2023). Among men, empowerment dimensions remain largely insignificant, while for women, they exert stronger but inconsistent effects. For example, control over credit is associated with lower rather than higher efficiency for the female farmers.

Moreover, within the models of the full sample, the estimates of technical efficiencies between male and female farmers are not significantly different and follow similar distribution patterns as shown in Figures 2a-2b. Given the inconsistent relationship between empowerment and efficiency, and the lack of statistically significant changes in coefficient magnitudes, there is no evidence of a predictive link between female farmers' empowerment and their comparative efficiency and productivity. Instead, this analysis points to the possibility that the observed parity in production between female and male farmers may stem more from differences in the composition and interaction of inputs, managerial characteristics, and empowerment levels, rather than empowerment alone. The potential mechanisms behind these disparities will be explored further in the subsequent sections of this paper.

[11] There are two categorical variables in this analysis: access to credit and control over credit. The same analysis as shown in Section 5.2 and Section 5.3 was run using indicator variables for each level of the categorical variables. The model would not converge for the female sub-sample with the indicator credit variables. There were not statistically significant differences between these estimates and the ones treating the credit-related variables as continuous. Therefore, for conciseness, the latter is shown here.

[12] For robust and clustered technical efficiency estimates, see Appendix Tables A.10-A.11.

Table 4
Sources of Technical Efficiency – Empowerment Metrics

Variable	Full Sample	Male Managed	Female Managed
	(1)	(2)	(3)
Productive Activities that the Manager Participates in	-0.048	-0.164**	0.758
	(0.061)	(0.081)	(0.495)
Level of Input in Productive Activities	-0.078	-0.065	0.987
	(0.089)	(0.113)	(0.776)
Level of Input on Income Use	-0.084	-0.070	-1.794*
	(0.075)	(0.093)	(0.774)
Percent of Assets Self-Owned	0.570**	0.305	2.405
	(0.269)	(0.413)	(1.713)
Access to Credit	0.072	-0.0559	1.620***
	(0.079)	(0.106)	(0.601)
Control over Credit	-0.046	-0.0170	-1.168**
	(0.087)	(0.123)	(0.559)
Prevalence of Manager's Input into Group Decisions	-0.102	-0.174*	0.411
	(0.070)	(0.089)	(0.510)
Average of Frequency that the Manager makes decisions because			
they fear they will get in trouble	0.112	0.198	0.066
	(0.111)	(0.134)	(0.823)
how others will view their actions	0.050	0.287**	-0.830
	(0.084)	(0.114)	(0.528)
they feel it is the right thing to do	0.316	0.504*	-0.871
	(0.227)	(0.274)	(1.805)
Percent of Household Decisions that the Manager has High Extent of Influence	0.016	-0.083	-0.057
	(0.060)	(0.078)	(0.435)
Hours Spent Farming or Fishing	-0.002	-0.030***	0.170***
	(0.008)	(0.011)	(0.058)
Hours Spent on Personal Care	0.141**	0.136	-1.279
	(0.070)	(0.083)	(0.811)
Hours Spent Cooking	-0.026	-0.063	0.254
	(0.046)	(0.107)	(0.210)
Hours Spent caring for Children or the Elderly	0.018	0.002	0.194**
	(0.019)	(0.033)	(0.086)
N (plots)	1,159	804	355
Constant	-0.0714	-2.108	11.91
	1.513	1.876	13.545

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Pearson Correlation Coefficients between all empowerment metrics for each sample are reported in Appendix Tables A.12-A.14. These results along with Variance Inflation Factor (VIF) tests and similar estimates when the empowerment metrics are dropped (results in Appendix Tables A.15-A.16) show no evidence of multicollinearity affecting model estimations. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

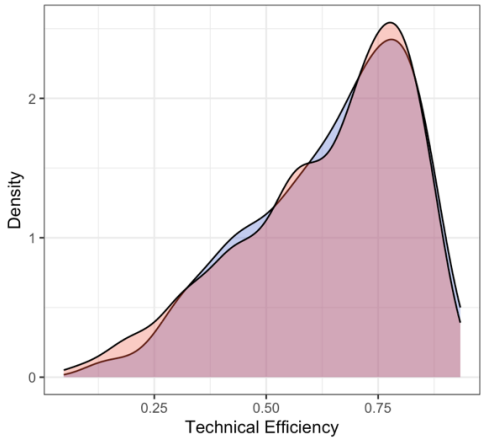


Fig. 2a: Distribution of Technical Efficiency in Model without Empowerment Metrics

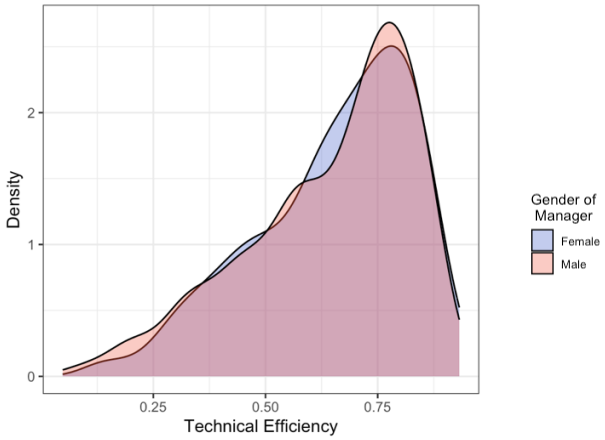


Fig. 2b: Distribution of Technical Efficiency in Model with Empowerment Metrics

Notes: Distribution for male farmers is in red and is in blue for female farmers. Together, the graphs show only slight differences between the distribution of technical efficiency between the model with and without empowerment metrics.

5.4 Robustness

5.4.1 WEAI Indexed Score

When using the WEAI index score rather than the decomposed measures, I find that for the full sample and the male-managed sub-sample, models including the index report lower BIC values and higher log-likelihoods in absolute terms, indicating modest improvements in fit (Appendix Table A.17). By contrast, in the female-managed sub-sample, the addition of the index did not improve model fit and it was the only sample with a significant coefficient on the indexed score variable within technical efficient estimates (Appendix Table A.18). Across all samples, however, the estimated input elasticities and efficiency scores were not significantly different between specifications. These results are broadly consistent with the main findings: empowerment measures do not substantively alter frontier estimates, and the female sub-sample remains the most sensitive to their inclusion.

5.4.2 Random Forest: Top Five Empowerment Dimensions

To assess the effect of only the most influential empowerment dimensions, I employ a random forest model, a non-parametric method that identifies which variables

contribute most to predictive accuracy. This approach consistently highlighted five measures across all three samples: percent of assets self-owned, hours spent sleeping or resting, level of input in productive activities, hours spent farming or fishing, and level of input on income use (Appendix 19). I then re-estimated the stochastic production frontier including only these five dimensions. The results closely mirror the baseline specification as the model without empowerment has a lower BIC and higher absolute log-likelihood, indicating overall better fit (Appendix Tables A.20 & A.21). These findings reinforce the conclusion that empowerment dimensions do not add explanatory value once production inputs are controlled for.

5.4.3 Kitagawa-Oaxaca-Blinder (KOB) Decomposition

Along with the stochastic production frontier model, estimates of the causes of gender productivity gaps are commonly examined using the Kitigawa-Oaxaca-Blinder (KOB) decomposition method (Aguilar et al., 2015; Slavchevska, 2015; Joe-Nkamuke et al., 2019; Islam & Amin, 2023). Table 5 presents the results of the KOB decomposition when performed with and without the empowerment metrics. Here, the endowment effect indicates how much of the production disparity can be explained by differences in the independent variables between groups. Conversely, the structural effect captures differences that result from variations in the coefficients, highlighting how much of the gap is due to factors other than the observed endowments. The interaction term represents the effect of the interaction between the endowment and structural effect (Kitagawa, 1955; Oaxaca, 1973; Blinder, 1973).

In models without empowerment, the endowment effects, which are driven largely by land area, account for most of the observed productivity differences. When empowerment is included, these endowment effects lose significance, suggesting that empowerment conditions the impact of inputs but does not independently explain production outcomes. Structural and interaction terms are insignificant in both specifications. This finding indicates that empowerment influences how inputs are used but does not serve as a direct driver of production outcomes. Therefore, the results of the KOB decomposition underscore those of the stochastic production frontier, where the relationship between empowerment and productivity differs between women and men and that this difference is not fully accounted for in standard empowerment metrics.

Table 5
Oaxaca-Blinder Decomposition Results between Models

	Without Empowerment Metrics	With Empowerment Metrics
Mean Output (Harvest Rice (kg)) for Male Farmers	6.830****	6.830****
Mean Output (Harvest Rice (kg)) for Female Farmers	6.724****	6.724****
Difference	0.106*	0.106*
Endowment Effect	0.148**	0.0659
Structural Effect	-0.00322	0.00605
Interaction	-0.0382	0.0342

Notes: The endowment effect represents the effect on the gendered difference in production that would occur if female farmers were given the same endowments as the male farmers at the mean. The structural effect represents the change in the difference if female farmers had the same coefficient as male farmers at the mean. The interaction term represents the change in difference based on the interaction between the endowment and structural effect. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

6 Potential Mechanisms

The stochastic frontier results suggest that empowerment influences efficiency differently across gendered sub-samples, with a stronger sensitivity observed among female farmers. At the same time, technical efficiency levels are broadly similar across men and women, implying that empowerment is not the primary driver of gender parity in productivity. These patterns point to the role of confounding factors. To explore these, I examine four potential mechanisms: input access, heterogeneity across empowerment dimensions, time allocation, and valuation of inputs.

6.1 Heterogeneity in Input Access

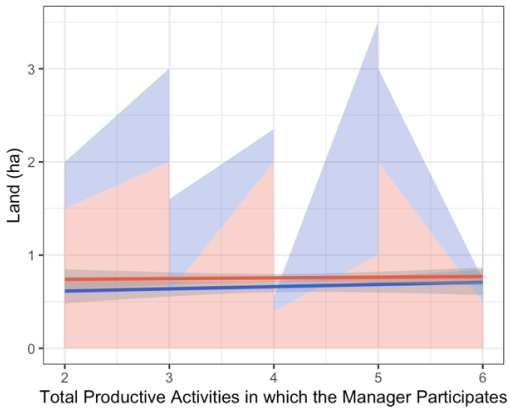
First, I examine whether the observed disparity in input availability among female farmers contributes to variations in the relationship between empowerment and technical efficiency across the gendered groups. I run the translog stochastic production function frontier models with additional managerial variables that accounted for which quartile an individual farmer was in for each input. The results of these estimations are presented in Appendix Tables A.22-A.24. The results show no meaningful changes for men, but for women the inclusion of empowerment metrics alongside input quartile controls leads to shifts in significance for both empowerment and input variables. This

suggests that disparities in access to inputs condition the relationship between empowerment and efficiency primarily for women, underscoring the role of gendered constraints in input use. Hence, there are likely gendered confounding factors connecting empowerment and inputs that are not being considered in the existing empowerment metrics.

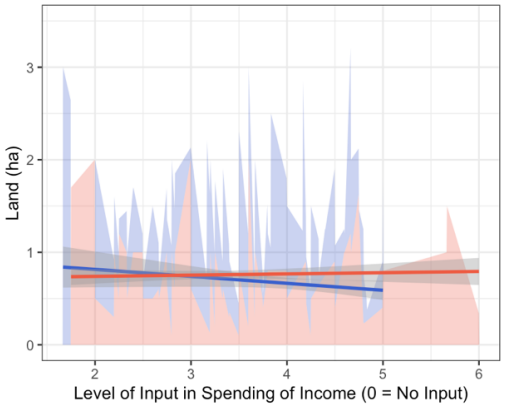
6.2 Heterogeneity Across Empowerment Metrics

An additional possible mechanism of the patterns seen in Section 5 is that certain empowerment metrics are more strongly correlated with higher rates of inputs or managerial variables than other empowerment metrics. To explore this possibility, the Pearson correlation coefficients between each empowerment, input, and managerial variable were calculated. For the full sample, time spent farming was the only empowerment metric consistently correlated with higher rates of inputs, but this correlation is relatively weak (see Appendix Table A.25 for correlation coefficient matrix between empowerment metrics and inputs). In contrast, several empowerment metrics were correlated with three or more managerial variables.

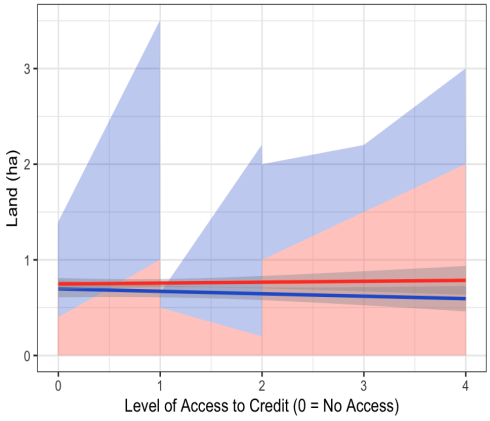
Correlation analysis shows that time spent farming is the only empowerment metric consistently associated with input use across the full sample, with stronger associations for men than women. Other empowerment measures correlate with several managerial variables, but these patterns do not differ systematically by gender. This is further reflected in Figures 3a-3d, that show the relationships between four empowerment metrics that were significant in one or more models in Section 5 and land area, each of which is similar between the female and male farmers. Thus, heterogeneity across empowerment dimensions does not appear to explain the divergent behavior of empowerment in production outcomes, pointing instead to unobserved confounding factors.



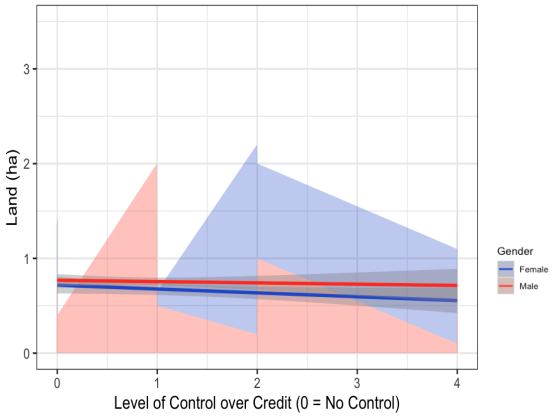
(Fig. 3a: Participation)



(Fig. 3b: Input on Income)



(Fig. 3c: Access to Credit)



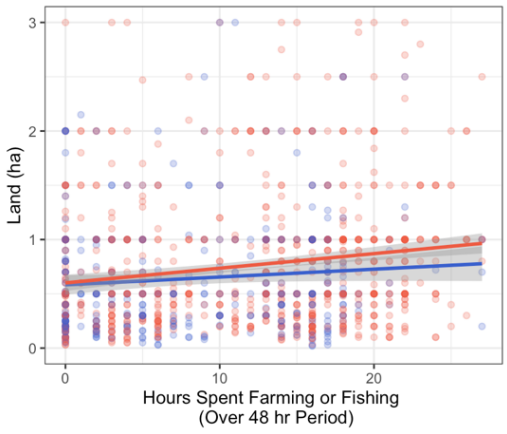
(Fig. 3d: Control over Credit)

Fig. 3a-3d: Effects of Empowerment Metrics on Land Size (ha)

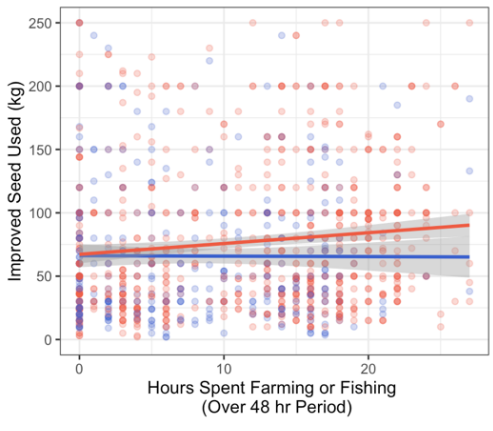
Notes: Shaded regions are overlapping area plots. Red shaded area represents male manager observations, while blue shaded area is the same for female managers. Red line represents line of best fit for male managers, while blue represents the same for female managers. Vertical axis limited for concise visualization; 16 observations not shown.

6.3 Allocation of Inputs based on Time Spent Farming

As women in the sample devote fewer hours to farming and more to domestic work relative to men, gendered differences in the impact of empowerment may be related to this time use. The relationship between the number of hours spent farming or fishing in a 48-hour span and each input is shown by gender in Figures 4a-4e. As seen, despite gender differences in time allocation, inputs were not allocated proportionally to hours spent in productive activities. This suggests that time use is not a channel through which empowerment affects productivity, and reinforces the likelihood of other confounding mechanisms.PE

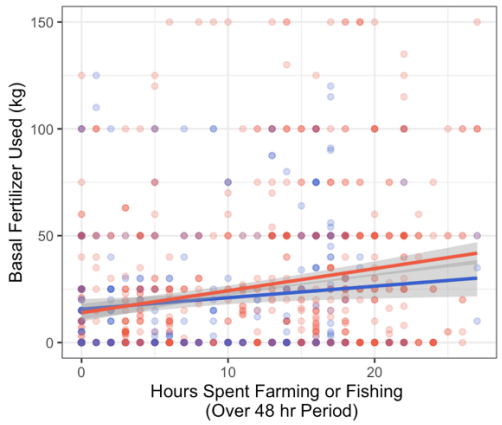


(Fig. 4a: Land Size)

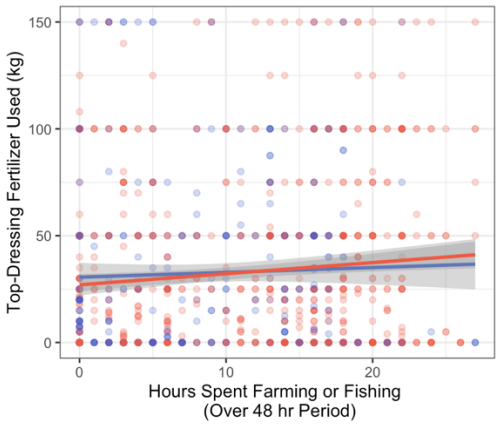


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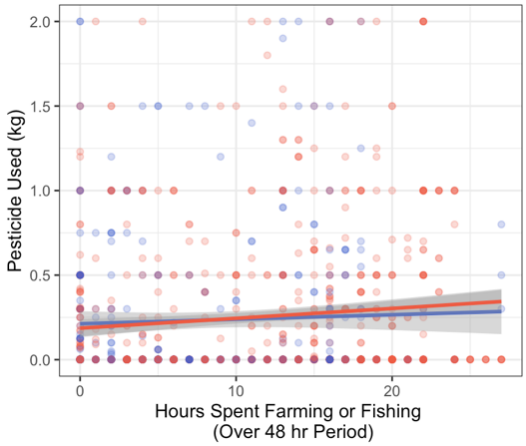
(Fig. 4b: Improved Seed)



(Fig. 4c: Basal Fertilizer)



(Fig. 4d: Top-Dressing Fertilizer)



(Fig. 4e: Pesticide)

Fig. 4a-4e: Relationship between Time Farming on Inputs

Notes: The red trendline shows the line of best fit between the variables for male managers, while the blue line shows the same for female managers. Confidence intervals are shaded in grey. Dots are plotting scatterplots by gender. The red dots represent observations for male managers, while the blue dots represent observations for the female managers. Limits were placed on vertical axis values for visual clarity of lines of best fits. 16 observations not shown on the graph for land area, 84 for improved seed, 13 for basal fertilizer, 78 for top-dressing fertilizer, and 65 for pesticide.

6.4 Perception on the Value of Inputs

An emerging theory in research on gender productivity gaps is the possibility that female farmers value agricultural inputs less than male farmers (Ajayi, 2006; Olum, 2020; Mastenbroek et al., 2021). If applicable to the sample used in this paper, this could explain why there were disparities in inputs that led to the gender production gap and in turn caused differences in the relationship between empowerment and productivity between the female and male farmers. However, tests of adoption of extension practices and input expenditures reveal no evidence that women systematically undervalue inputs relative to men (results presented in Appendix Table A.26). Findings show that adoption rates of recommended extension practices are similar across genders, and in some cases, women pay higher prices for inputs such as basal fertilizer while men pay more for seed. Altogether, this implies that female farmers' lower rates of inputs are likely not caused by them placing lower value on the inputs. Further, there is evidence that female farmers were paying higher market prices for at least one of the inputs.

7 Concluding Remarks

This paper has examined the relationship between empowerment and agricultural productivity in the context of Cambodian rice farmers, where women are as empowered as men and gender yield gaps are absent. By applying stochastic frontier models, Kitagawa–Oaxaca–Blinder decompositions, and gender-disaggregated subsamples, the study has sought to test whether empowerment metrics robustly explain productivity in a setting that differs markedly from those that dominate the existing literature. Three contributions emerge from this analysis. First, the use of stochastic frontier methods offers a more nuanced econometric approach to assessing how empowerment shapes technical efficiency and production, going beyond average treatment effects to examine underlying production functions. Second, the decomposition of the WEAI illustrates that empowerment is not a monolithic construct; some dimensions, such as credit access and time use, may matter more than others, while others appear unrelated or even negatively related to efficiency. Third, by estimating models separately for men and women, the study demonstrates how aggregate results can obscure gender heterogeneity, revealing that empowerment metrics are more consequential for women, though in inconsistent and sometimes counterintuitive ways.

The findings carry several implications for the study of gender, empowerment, and agricultural value chains. At a substantive level, the results challenge the assumption

that empowerment universally enhances productivity. In Cambodia, empowerment adds little explanatory power to production models and does not consistently improve efficiency, despite women's equal or greater empowerment relative to men. Instead, empowerment interacts with input access and market conditions, underscoring that structural constraints condition whether and how empowerment translates into productivity gains. The results should therefore be interpreted as identifying boundary conditions: empowerment measures are not universally predictive of productivity, and their explanatory power depends on broader contexts. Future comparative work across settings, with and without gender gaps, and across different crops and value chains, will be essential to clarify sociocultural influences on agricultural performance.

For future research, these results therefore highlight the need to situate empowerment within broader institutional, social, and market contexts. Future work should move beyond aggregate empowerment indices to investigate which dimensions matter most, how they interact with resource allocation, and under what conditions they influence productivity. There is also a need to explore other dimensions around individual well-being and their potential impact on productivity. Comparative evidence across contexts, with and without gender gaps, will be essential to clarify when empowerment metrics are useful predictors of agricultural performance.

For policy and extension practice, the results suggest that interventions designed to raise productivity should not rely solely on empowerment indicators as diagnostic tools. While strengthening empowerment remains a critical goal for enhancing autonomy and agency, widespread productivity gains are unlikely unless structural constraints in value chains, such as access to land, input markets, and credit, are simultaneously addressed. Policies that integrate gender-sensitive empowerment initiatives with investments in supply chain governance and resource distribution will therefore be more effective than those targeting empowerment in isolation.

In conclusion, the Cambodian case demonstrates that empowerment is neither irrelevant nor universally determinative to productivity. Its effects on productivity are contingent on structural and market conditions, with implications for how researchers conceptualize empowerment, how policymakers design interventions, and how practitioners seek to strengthen the growth and resilience of agricultural value chains. By combining methodological innovation with contextual analysis, this study contributes to a more nuanced understanding of the empowerment–productivity nexus and its role in shaping expansive agricultural development.

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A Appendix

Table A.1: Calculation of Empowerment Metrics

Empowerment Metric	Calculation
Total Productive Activities that the Manager Participates in	Sum of activities that the manager participated in that involved production and/or income. (Activities included: (1) Food crop farming: crops that are grown primarily for household food consumption; (2) Cash crop farming: crops that are grown primary for sale in the market; (3) Livestock raising; (4) Non-farm economic activities: Small business, self-employment, buy-and-sell; (5) Wage and salary employment: in-kind or monetary work both agriculture and other wage work; and (6) Fishing or fishpond culture.)
Level of Input in Productive Activities	Average input in decisions on activities that involved production and/or income. (1 - No input; 2 - Input into very few decisions; 3 - Input into some decisions; 4 - Input into most decisions; 5 - Input into all decisions)
Level of Input on Income Use	Average input in decisions on how to spend income made from activities that involved production and/or income. (1 - No input; 2 - Input into very few decisions; 3 - Input into some decisions; 4 - Input into most decisions; 5 - Input into all decisions)
Percent of Assets Self-Owned	Percentage of productive assets that respondent reported as self-owned out of 14 productive assets. (Assets included: Agricultural land (pieces/plots); Large livestock (oxen, cattle); Small livestock (goats, pigs, sheep); Chickens, Ducks, Turkeys, Pigeons; Fish pond or fishing equipment; Farm equipment (non-mechanized); Farm equipment (mechanized); Nonfarm business equipment; House (and other structures); Large consumer durables (fridge, TV, sofa); Small consumer durables (radio, cookware); Cell phone; Other land not used for agricultural purposes (pieces, residential or commercial land); Means of transportation (bicycle, motorcycle, car)
Access to Credit	Based on the self-reported number of loans and/or borrowed cash or in-kind payments. Index where 0 is no access, 1 is little access, 2 is some access, 3 is high access, and 4 is full access.
Control over Credit	Based on share of reported lines of credit that the respondent made decisions regarding how to spend/use the credit. Index where 0 is no access, 1 is little access, 2 is some access, 3 is high access, and 4 is full access.

Table A.1 Cont.: Calculation of Empowerment Metrics

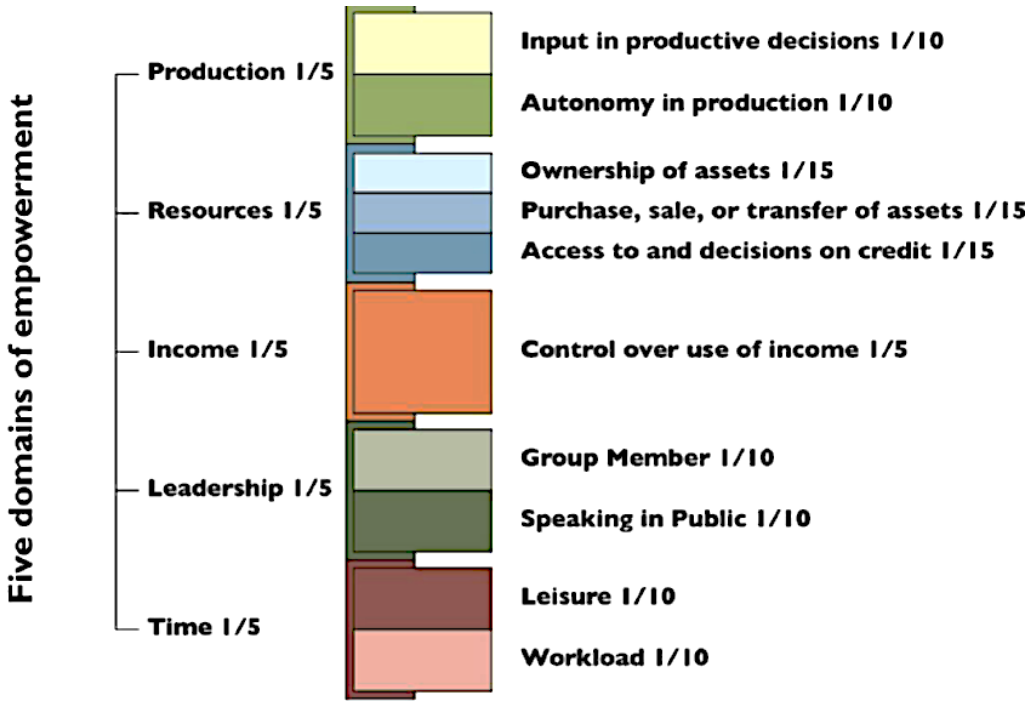
Empowerment Metric	Calculation
Total Groups the Manager is Highly Active in	Sum agriculture groups the manager reported themselves as being highly active in. (Groups included: Agricultural / livestock/ fisheries producer's group (including marketing groups); Water users' group; Forest users' group; Credit or microfinance group (e.g. saving group); Mutual help or insurance group (including burial societies); Trade and business association; Civic groups (improving community) or charitable group (helping others); Local government (example, commune council, any committee under the commune council, etc); Religious group (example, pagoda group); Other women's group (only if it does not fit into one of the other categories); Option for Other (specify))
Prevalence of Manager Having Input into All Group Decisions	Share of groups where respondent reported having input into all decisions.
Average of Frequency that the Manager makes decisions because	
they fear they will get in trouble	Average of decisions the respondent makes out of fear they will get in trouble. (Decision on the following topics: Getting inputs for agricultural production; The types of crops to grow for agricultural production; Taking crops to the market (or not); Livestock raising; Fishing or fishpond culture)
how others will view their actions	Average of decisions the respondent makes so that others do not think poorly of them. (Decision on the following topics: Getting inputs for agricultural production; The types of crops to grow for agricultural production; Taking crops to the market (or not); Livestock raising; Fishing or fishpond culture)
they feel it is the right thing to do	Average of decisions the respondent makes out of feeling it is the right thing to do. (Decision on the following topics: Getting inputs for agricultural production; The types of crops to grow for agricultural production; Taking crops to the market (or not); Livestock raising; Fishing or fishpond culture)
Percent of Household Decisions that the Manager has High Extent of Influence	Share of decisions within the household that the respondent reported having a high degree of influence over.
Hours Spent Farming or Fishing Hours Spent on Personal Care Hours Spent Cooking Hours Spent caring for Children or the Elderly Hours Spent Sleeping or Resting	Total hours reported for each activity based on recall of last 48 hours.

Notes: Each metric was calculated using questions asked in the HARVEST survey. Each of these questions a derived from IFPRI's WEAI and based on the corresponding theory (Alkire et al., 2013)

A.2: Calculating the WEAI Score

The following steps have been derived from Alkire et al. (2013), the work that established the WEAI.

Step 1: Calculate the Five Domains of Empowerment (5DE) score using responses to the WEAI module and weighting them as shown in the figure below.



Step 2: Calculate the Gender Parity Index (GPI) score where H_{GPI} represents aggregated household level gender parity and I_{GPI} represents aggregated censored empowerment scores among households that lack gender parity (these scores are censored in order to limit the impact of already empowered individuals).

$$GPI = 1 - (H_{GPI} \text{ X } I_{GPI})$$

Step 3: Calculate the WEAI score with 90% weight given to the 5DE score and 10% weight given to the GPI score.

$$WEAI = 0.9(5DE) + 0.1(GPI)$$

Table A.3a: Stochastic Production Frontier Estimates using Cobb-Douglas Specification

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.016****	1.004****	1.108****	1.146****	0.731****	0.725****
	(0.060)	(0.060)	(0.075)	(0.077)	(0.131)	(0.133)
Quantity of Improved Seed (Seed) (kg)	0.001	0.001*	0.0002	0.0001	0.004****	0.004****
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)
Quantity of Basal Fertilizer (Bfert) (kg)	0.003****	0.003****	0.002**	0.002*	0.003**	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.004****	0.004****	0.003****	0.003****	0.007****	0.007****
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Quantity of Pesticide (Pest) (kg)	0.097***	0.094***	0.099***	0.083**	0.056	0.039
	(0.030)	(0.030)	(0.035)	(0.033)	(0.083)	(0.085)
Number of Hired Laborers (Labor)	0.023****	0.023****	0.021****	0.019****	0.02****	0.028****
	(0.002)	(0.002)	(0.003)	(0.003)	(0.005)	(0.005)
Harv X Seed	-0.001****	-0.001****	-0.001****	-0.001****	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Harv X Bfert	-0.001****	-0.001****	-0.001**	-0.001**	0.0003	0.0003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Harv X Tfert	-0.0004**	-0.0004**	-0.0004	-0.0004	-0.0001	-0.0004
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.001)	(0.001)
Harv X Pest	-0.027	-0.032	0.004	0.006	0.015	0.015
	(0.024)	(0.024)	(0.032)	(0.031)	(0.051)	(0.049)
Harv X Labor	-0.008****	-0.007****	-0.008****	-0.008****	-0.001	-0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)

Table A.3a cont.: Stochastic Production Frontier Estimates using Cobb-Douglas Specification

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Labor X Bfert	0.00001	0.00001	0.00001	0.00002	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Labor X Tfert	-0.0001****	-0.0001****	0.00**	0.00**	0.00****	0.00****
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Labor X Pest	0.002	0.004	-0.005	-0.005	-0.011	-0.012
	(0.006)	(0.006)	(0.008)	(0.008)	(0.023)	(0.022)
Temperature (C°)	0.531****	0.540****	0.542****	0.571****	0.630****	0.521****
	(0.074)	(0.075)	(0.090)	(0.091)	(0.134)	(0.139)
Rainfall (mm)	-0.0005***	-0.0005***	-0.0005**	-0.0005**	-0.0004	-0.0001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-7.992****	-8.223****	-8.250****	-9.015****	-11.12***	-8.585**
	(2.038)	(2.060)	(2.461)	(2.488)	(3.750)	(3.916)
σ_v^2	0.292	0.298	0.265	0.277	0.317	0.365
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.06)
Log-Likelihood	-926.001	-909.143	-642.593	-622.419	-254.275	-240.228
Bayesian Information Criterion (BIC)	2084.856	2171.095	1499.293	1572.689	696.459	768.189
Wald $\chi^2(16)$	2213.200****	2166.540****	1584.06****	1571.700****	783.82****	743.02****
Log-Likelihood Ratio Test Statistic	33.72***		40.35***		28.10**	

Notes: Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.3b: Sources of Technical Inefficiency from Estimates using Cobb-Douglas Specification

Variable	Full Sample (N=688)		Male Managed (N=527)		Female Managed (N=161)	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.00191	0.106	————	————	————	————
	(0.109)	(0.166)	————	————	————	————
Age	-0.059*	-0.054	-0.037	-0.024	-0.143*	-0.194
	(0.032)	(0.034)	(0.036)	(0.040)	(0.083)	(0.121)
Age^2	0.001*	0.001*	0.0005	0.0003	0.002*	0.002*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Literacy Score	-0.011	-0.004	0.002	0.031	-0.109	-0.163
	(0.058)	(0.063)	(0.077)	(0.083)	(0.104)	(0.141)
Highest Grade of Education	0.008	0.012	-0.001	0.01	0.018	-0.005
	(0.014)	(0.016)	(0.017)	(0.019)	(0.030)	(0.043)
Control for Plots being Managed by the Same Manager	-0.002****	-0.002****	-0.002****	-0.002***	-0.003***	-0.003*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Number of Plots Managed by Same Manager	0.042	0.037	0.077	0.130	-0.155	-0.259
	(0.064)	(0.071)	(0.074)	(0.081)	(0.150)	(0.208)
Number of Plots Managed by Same $Manager^2$	0.0001	0.003	-0.004	-0.008	0.019	0.037*
	(0.005)	(0.006)	(0.006)	(0.006)	(0.013)	(0.019)
Tenancy Status	-0.211	-0.243	-0.218	-0.298	-0.226	-0.072
	(0.154)	(0.161)	(0.181)	(0.194)	(0.329)	(0.422)
Disease and pest control	-0.054	-0.005	-0.064	-0.075	0.176	0.456
	(0.125)	(0.133)	(0.150)	(0.165)	(0.255)	(0.374)
Organic residue management	-0.062	-0.172	-0.114	-0.190	-0.015	-0.114
	(0.138)	(0.149)	(0.162)	(0.182)	(0.309)	(0.426)
Irrigation	0.110	0.126	0.233	0.296	0.010	0.061
	(0.159)	(0.173)	(0.199)	(0.225)	(0.335)	(0.486)

Table A.3b Cont.: Sources of Technical Inefficiency from Estimates using Cobb-Douglas Specification

	Full Sample (N=688)		Male Managed (N=527)		Female Managed (N=161)	
Variable	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	-0.030	0.079	0.155	0.327	-0.056	0.135
	(0.285)	(0.316)	(0.340)	(0.389)	(0.610)	(0.921)
Village	0.00***	0.00**	0.00*	0.00*	0.00***	0.00
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Productive Activities that the Manager Participates in		-0.091		-0.169**		0.014
		(0.058)		(0.073)		(0.161)
Level of Input in Productive Activities		-0.039		-0.012		0.111
		(0.084)		(0.102)		(0.242)
Level of Input on Income Use		-0.127*		-0.070		-0.532*
		(0.069)		(0.084)		(0.291)
Percent of Assets Self-Owned		0.718***		0.699*		1.136*
		(0.255)		(0.374)		(0.649)
Access to Credit		0.026		-0.024		0.289
		(0.075)		(0.100)		(0.193)
Control over Credit		-0.045		-0.088		-0.149
		(0.081)		(0.119)		(0.177)
Total Groups the Manager is Highly Active in		0.015		0.054		0.031
		(0.042)		(0.050)		(0.123)
Prevalence of Manager Having Input into All Group Decisions		-0.149**		-0.212***		-0.082
		(0.068)		(0.082)		(0.211)
they fear they will get in trouble		0.045		0.113		-0.031
		(0.107)		(0.124)		(0.345)
how others will view their actions		-0.065		0.162		-0.199
		(0.080)		(0.105)		(0.253)
they feel it is the right thing to do		0.454**		0.542**		-0.506
		(0.222)		(0.253)		(0.743)

Table A.3b Cont.: Sources of Technical Inefficiency from Estimates using Cobb-Douglas Specification

	Full Sample (N=688)		Male Managed (N=527)		Female Managed (N=161)	
Variable	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Prevalence of Manager Having Input into All Group Decisions		-0.053		-0.093		0.040
		(0.058)		(0.073)		(0.139)
Hours Spent Farming or Fishing		0.002		-0.022**		0.066*
		(0.008)		(0.010)		(0.038)
Hours Spent on Personal Care		0.121*		0.154**		-0.096
		(0.065)		(0.076)		(0.217)
Hours Spent Cooking		-0.025		-0.054		0.045
		(0.043)		(0.098)		(0.074)
Hours Spent caring for Children or the Elderly		0.011		0.010		0.028
		(0.019)		(0.030)		(0.041)
Hours Spent Sleeping or Resting		0.0002		-0.018		0.026
		(0.012)		(0.014)		(0.043)
Constant	1.562*	0.159	0.878	-1.172	3.030	5.573
	(0.881)	(1.421)	(1.019)	(1.688)	(1.990)	(4.489)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.4: Stochastic Production Frontier Estimates on Output of Harvested Rice

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096****	1.192****	1.140***	1.303****	1.502**	1.589**
	(0.323)	(0.328)	(0.387)	(0.390)	(0.627)	(0.630)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.089	0.078	-0.055	-0.655	-0.921
	(0.308)	(0.315)	(0.363)	(0.369)	(0.592)	(0.591)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.003	0.002	-0.004	-0.008	-0.003
	(0.012)	(0.012)	(0.014)	(0.014)	(0.024)	(0.024)
Quantity of Top-Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.048****	0.077***	0.079***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.025)	(0.026)
Quantity of Pesticide (Pest) (kg)	0.043	0.044	0.067**	0.054	0.008	0.079
	(0.028)	(0.028)	(0.033)	(0.033)	(0.056)	(0.056)
Number of Hired Laborers (Labor)	-0.252****	-0.261****	-0.217***	-0.209***	-0.327***	-0.377***
	(0.058)	(0.059)	(0.067)	(0.066)	(0.121)	(0.120)
1/2 Land^2	0.088	0.111	0.104	0.146	0.108	0.127
	(0.081)	(0.082)	(0.100)	(0.101)	(0.150)	(0.153)
1/2 Seed^2	-0.009	0.010	-0.036	-0.010	0.164	0.217*
	(0.067)	(0.069)	(0.078)	(0.080)	(0.131)	(0.131)
1/2 Bfert^2	0.009	0.009	0.007	0.007	0.004	0.011
	(0.007)	(0.007)	(0.008)	(0.008)	(0.013)	(0.013)
1/2 Tfert^2	0.015***	0.016***	0.010	0.010	0.024***	0.020**
	(0.005)	(0.005)	(0.007)	(0.007)	(0.009)	(0.010)
1/2 Pest^2	-0.009	-0.008	0.000	-0.002	-0.022	-0.011
	(0.007)	(0.007)	(0.008)	(0.008)	(0.014)	(0.014)
1/2 Labor^2	0.133****	0.137****	0.112****	0.109****	0.196****	0.202****
	(0.027)	(0.027)	(0.031)	(0.031)	(0.053)	(0.053)
Land X Seed	-0.017	-0.037	0.006	-0.021	-0.190	-0.206
	(0.064)	(0.066)	(0.076)	(0.077)	(0.127)	(0.126)

Table A.4 Continued: Stochastic Production Frontier Estimates on Output of Harvested Rice

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Bfert	-0.004	-0.005	-0.003	-0.004	-0.002	-0.003
	(0.004)	(0.004)	(0.005)	(0.005)	(0.008)	(0.008)
Land X Tfert	0.003	0.003	0.006	0.003	-0.002	0.000
	(0.004)	(0.004)	(0.006)	(0.006)	(0.009)	(0.009)
Land X Pest	0.029****	0.029****	0.031****	0.031****	0.026*	0.027*
	(0.007)	(0.007)	(0.008)	(0.008)	(0.013)	(0.014)
Land X Labor	-0.086****	-0.087****	-0.100****	-0.106****	-0.060	-0.058
	(0.023)	(0.023)	(0.027)	(0.028)	(0.046)	(0.044)
Labor X Bfert	0.006**	0.007**	0.005	0.006*	0.011*	0.014**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)
Labor X Tfert	-0.010***	-0.010***	-0.010**	-0.007*	-0.009	-0.010
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)
Labor X Pest	-0.012**	-0.012**	-0.011*	-0.008	-0.013	-0.026**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.012)	(0.012)
Temperature (C°)[a]	0.354****	0.355****	0.372****	0.381****	0.477****	0.249*
	(0.073)	(0.074)	(0.089)	(0.089)	(0.136)	(0.130)
Rainfall (mm)[a]	-0.0007****	-0.0006****	-0.0007****	-0.0007****	-0.0008**	-0.0004
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Constant	-1.175	-1.031	-1.542	-1.486	-3.453	2.915
	(2.197)	(2.219)	(2.716)	(2.713)	(4.034)	(4.093)
σ_v^2	0.275	0.281	0.263	0.274	0.288	0.375
	(0.018)	(0.018)	(0.020)	(0.021)	(0.033)	(0.016)
N (plots)	1,159	1,159	804	804	355	355
Log-Likelihood	-766.154	-756.277	-533.284	-517.293	-206.473	-184.617
Bayesian Information Criterion (BIC)	1807.466	1907.651	1320.77	1402.514	636.086	692.201
Wald $\chi^2(22)$	4004.06****	3879.77****	2867.77****	2798.46****	1512.35****	1491.90****
Log-Likelihood Ratio Test Statistic	19.76		31.98**		43.17****	

Notes: a. Province level; All six inputs are in logarithmic form, including for squared and interaction terms. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.5: Stochastic Production Frontier Estimates on Output of Harvested Rice from Models with Robust Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096***	1.192****	1.140***	1.303****	1.502**	1.589**
	(0.356)	(0.352)	(0.382)	(0.371)	(0.726)	(0.687)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.089	0.078	-0.055	-0.655	-0.921
	(0.340)	(0.338)	(0.337)	(0.338)	(0.679)	(0.607)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.003	0.002	-0.004	-0.008	-0.003
	(0.012)	(0.012)	(0.014)	(0.014)	(0.022)	(0.024)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.048***	0.077***	0.079***
	(0.012)	(0.013)	(0.015)	(0.015)	(0.024)	(0.028)
Quantity of Pesticide (Pest) (kg)	0.043	0.044	0.067**	0.054*	0.008	0.079
	(0.028)	(0.028)	(0.032)	(0.032)	(0.055)	(0.055)
Number of Hired Laborers (Labor)	-0.252****	-0.261****	-0.217****	-0.209****	-0.327***	-0.377***
	(0.056)	(0.056)	(0.063)	(0.062)	(0.118)	(0.133)
1/2 Land^2	0.0878	0.111	0.104	0.146	0.108	0.127
	(0.092)	(0.092)	(0.107)	(0.105)	(0.178)	(0.176)
1/2 Seed^2	-0.009	0.010	-0.036	-0.010	0.164	0.217*
	(0.075)	(0.074)	(0.074)	(0.075)	(0.147)	(0.131)
1/2 Bfert^2	0.009	0.010	0.007	0.010	0.004	0.011
	(0.007)	(0.007)	(0.008)	(0.008)	(0.012)	(0.013)
1/2 Tfert^2	0.015***	0.016***	0.010	0.010	0.024***	0.020**
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.009)
1/2 Pest^2	-0.009	-0.008	-0.0004	-0.002	-0.022	-0.011
	(0.008)	(0.008)	(0.009)	(0.009)	(0.014)	(0.015)
1/2 labor^2	0.133****	0.137****	0.112****	0.109****	0.196****	0.202****
	(0.026)	(0.026)	(0.028)	(0.029)	(0.054)	(0.058)

Table A.5 Cont.: Stochastic Production Frontier Estimates on Output of Harvested Rice from Models with Robust Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Seed	-0.017	-0.037	0.006	-0.021	-0.190	-0.206
	(0.073)	(0.072)	(0.076)	(0.074)	(0.145)	(0.133)
Land X Bfert	-0.004	-0.005	-0.003	-0.004	-0.002	-0.003
	(0.005)	(0.005)	(0.006)	(0.005)	(0.007)	(0.008)
Land X Tfert	0.003	0.003	0.006	0.003	-0.002	-0.0005
	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)
Land X Pest	0.029****	0.029****	0.031***	0.031***	0.026**	0.027*
	(0.008)	(0.008)	(0.010)	(0.010)	(0.013)	(0.014)
Land X Labor	-0.086****	-0.087****	-0.100****	-0.106****	-0.060	-0.058
	(0.023)	(0.024)	(0.028)	(0.029)	(0.037)	(0.038)
Labor X Bfert	0.006**	0.007**	0.005	0.006**	0.011**	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
Labor X Tfert	-0.010***	-0.010***	-0.010**	-0.007*	-0.009	-0.010
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.009)
Labor X Pest	-0.012**	-0.012**	-0.011*	-0.008	-0.013	-0.026**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.012)	(0.012)
Temperature (C°)	0.354****	0.355****	0.372****	0.381****	0.477****	0.249*
	(0.077)	(0.079)	(0.092)	(0.096)	(0.140)	(0.151)
Rainfall (mm)	-0.0007****	-0.0006***	-0.0007***	-0.0007***	-0.0008**	-0.0004
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0003)
Constant	-1.175	-1.031	-1.542	-1.486	-3.453	2.915
	(2.350)	(2.406)	(2.749)	(2.885)	(4.157)	(4.713)
σ_v^2	0.275	0.281	0.263	0.274	0.288	0.375
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
N (plots)	1,159	1,159	804	804	355	355
Log-pseudolikelihood	-766.154	-766.277	-533.284	-517.293	-206.473	-184.617
Bayesian Information Criterion (BIC)	1807.466	1907.651	1320.772	1402.514	636.09	692.2
Wald $\chi^2(22)$	4331.06****	4163****	3185.64****	3010.90****	1792.42****	1794.42****

Notes: Coefficients are rounded to the thousandths place when feasible. Robust Huber-White standard errors are in parentheses. Log-likelihood ratio test statistic not reliable for robust standard errors. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.6: Stochastic Production Frontier Estimates with Standard Errors Clustered at Commune Level

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096**	1.192**	1.140**	1.303**	1.502**	1.589***
	(0.450)	(0.469)	(0.537)	(0.531)	(0.658)	(0.616)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.089	0.078	-0.055	-0.655	-0.921
	(0.487)	(0.516)	(0.481)	(0.472)	(0.847)	(0.929)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.003	0.002	-0.004	-0.008	-0.003
	(0.013)	(0.013)	(0.016)	(0.018)	(0.025)	(0.024)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.048****	0.077**	0.079**
	(0.015)	(0.015)	(0.015)	(0.014)	(0.033)	(0.035)
Quantity of Pesticide (Pest) (kg)	0.043	0.044	0.067**	0.054	0.008	0.079
	(0.030)	(0.030)	(0.033)	(0.033)	(0.065)	(0.065)
Number of Hired Laborers (Labor)	-0.252****	-0.261****	-0.217***	-0.209***	-0.327**	-0.377***
	(0.054)	(0.062)	(0.074)	(0.079)	(0.135)	(0.132)
1/2 $Land^2$	0.088	0.111	0.104	0.146	0.108	0.127
	(0.092)	(0.096)	(0.125)	(0.126)	(0.144)	(0.130)
1/2 $Seed^2$	-0.009	0.010	-0.036	-0.010	0.164	0.217
	(0.107)	(0.113)	(0.105)	(0.103)	(0.189)	(0.205)
1/2 $Bfert^2$	0.009	0.009	0.007	0.007	0.004	0.011
	(0.007)	(0.007)	(0.009)	(0.010)	(0.016)	(0.016)
1/2 $Tfert^2$	0.015	0.016	0.010	0.010	0.024**	0.020*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.012)	(0.012)
1/2 $Pest^2$	-0.009	-0.008	-0.0004	-0.002	-0.022	-0.011
	(0.006)	(0.007)	(0.007)	(0.007)	(0.017)	(0.017)
1/2 $labor^2$	0.133****	0.137****	0.112****	0.109***	0.196***	0.202***
	(0.026)	(0.029)	(0.032)	(0.035)	(0.066)	(0.066)

Table A.6 Cont.: Stochastic Production Frontier Estimates with Standard Errors Clustered at Commune Level

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Seed	-0.017	-0.037	0.006	-0.021	-0.190	-0.206
	(0.094)	(0.097)	(0.105)	(0.102)	(0.132)	(0.135)
Land X Bfert	-0.004	-0.005	-0.003	-0.004	-0.002	-0.003
	(0.005)	(0.005)	(0.005)	(0.006)	(0.008)	(0.008)
Land X Tfert	0.003	0.003	0.006	0.003	-0.002	-0.001
	(0.006)	(0.007)	(0.006)	(0.006)	(0.011)	(0.012)
Land X Pest	0.029****	0.029****	0.031****	0.031***	0.026	0.027*
	(0.007)	(0.007)	(0.009)	(0.010)	(0.017)	(0.015)
Land X Labor	-0.086****	-0.087****	-0.100****	-0.106****	-0.060	-0.058
	(0.026)	(0.026)	(0.029)	(0.029)	(0.051)	(0.043)
Labor X Bfert	0.006*	0.007*	0.005	0.006*	0.011*	0.014***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	(0.005)
Labor X Tfert	-0.010**	-0.010**	-0.009*	-0.007*	-0.009	-0.010
	(0.004)	(0.004)	(0.005)	(0.004)	(0.010)	(0.012)
Labor X Pest	-0.012*	-0.012*	-0.011	-0.008	-0.013	-0.026**
	(0.007)	(0.007)	(0.008)	(0.008)	(0.014)	(0.011)
Temperature (C°)	0.354**	0.355**	0.372**	0.381**	0.477**	0.249
	(0.164)	(0.172)	(0.157)	(0.173)	(0.218)	(0.193)
Rainfall (mm)	-0.001	-0.001	-0.001*	-0.001**	-0.001	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.175	-1.031	-1.542	-1.486	-3.453	2.915
	(4.711)	(4.962)	(4.693)	(5.135)	(6.139)	(5.989)
σ_v^2	-2.580****	-2.540****	-2.674****	-2.586****	-2.487****	-1.961****
	(0.192)	(0.217)	(0.176)	(0.190)	(0.292)	(0.137)
N (plots)	1,159	1,159	804	804	355	355
Log-pseudolikelihood	-766.154	-756.277	-533.284	-517.293	-206.473	-184.617
Bayesian Information Criterion (BIC)	1765.134	1738.323	1267.255	1228.585	583.236	545.398

Notes: Standard errors clustered at the commune level (33 total communes). Log-likelihood ratio test statistic and Wald test statistic not reliable for this clustering strategy. Coefficients are rounded to the thousandths place when feasible. Standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.7: Marginal Elasticities of Inputs at the Mean from Models with Robust Standard Errors

Input	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Land Area (Land) (ha)	-0.0948***	-0.1003****	-0.0901***	-0.1030****	-0.1560**	-0.1730**
	(0.0308)	(0.0210)	(0.0306)	(0.0309)	(0.0652)	(0.0684)
Quantity of Improved Seed (Seed) (kg)	0.00308	-0.0500	0.0444	-0.0311	-0.360	-0.527
	(0.1910)	(0.2150)	(0.2060)	(0.2100)	(0.3250)	(0.3390)
Quantity of Basal Fertilizer (Bfert) (kg)	-0.0006	-0.0004	-0.0002	0.0004	0.0016	0.0006
	(0.0017)	(0.0013)	(0.0016)	(0.0016)	(0.0052)	(0.0054)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.0020****	0.0020****	0.0016****	0.0014****	0.0028***	0.0030***
	(0.0004)	(0.0006)	(0.0004)	(0.0004)	(0.0009)	(0.0010)
Quantity of Pesticide (Pest) (kg)	-0.0246	-0.0256*	-0.0379**	-0.0303	-0.0047	-0.0511
	(0.0163)	(0.0133)	(0.0187)	(0.0186)	(0.0350)	(0.0364)
Number of Hired Laborers (Labor)	-0.0714****	-0.0741****	-0.0617***	-0.0595***	-0.0926***	-0.1110***
	(0.0158)	(0.0122)	(0.0191)	(0.0189)	(0.0344)	(0.0353)
N (plots)	1,159	1,159	804	804	355	355

Notes: Coefficients are rounded to the ten-thousandths. t-statistics are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.8: Marginal Elasticities of Inputs at the Mean from Model with Standard Errors Clustered at Commune Level

Input	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Land Area (Land) (ha)	-0.0948****	-0.103****	-0.0901***	-0.103****	-0.156**	-0.173**
	(0.0170)	(0.0210)	(0.0306)	(0.0309)	(0.0652)	(0.0684)
Quantity of Improved Seed (Seed) (kg)	0.00308	-0.0500	0.0444	-0.0311	-0.360	-0.527
	(0.2020)	(0.2150)	(0.2060)	(0.2100)	(0.3250)	(0.3390)
Quantity of Basal Fertilizer (Bfert) (kg)	-0.0006	-0.0004	-0.0002	0.0004	0.0016	0.0006
	(0.0015)	(0.0013)	(0.0016)	(0.0016)	(0.0052)	(0.0054)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.0020****	0.0020****	0.0016****	0.0014****	0.0028***	0.0030***
	(0.0006)	(0.0006)	(0.0004)	(0.0004)	(0.0009)	(0.0010)
Quantity of Pesticide (Pest) (kg)	-0.0246**	-0.0256*	-0.0379**	-0.0303	-0.0047	-0.0511
	(0.0121)	(0.0133)	(0.0187)	(0.0186)	(0.0350)	(0.0364)
Number of Hired Laborers (Labor)	-0.0714****	-0.0741****	-0.0617***	-0.0595***	-0.0926***	-0.111***
	(0.0144)	(0.0122)	(0.0191)	(0.0189)	(0.0344)	(0.0353)
N (plots)	1,159	1,159	804	804	355	355

Notes: Coefficients are rounded to the ten-thousandths. Clustered standard errors are in parentheses. p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.9: Sources of Technical Inefficiency

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.064	————	————	————	————
	(0.116)	(0.180)	————	————	————	————
Age	-0.044	-0.036	-0.014	0.0176	-0.209**	-0.822**
	(0.034)	(0.037)	(0.039)	(0.044)	(0.087)	(0.400)
Age^2	0.0010	0.0010	0.0003	0.0000	0.003***	0.011**
	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0010)	(0.0049)
Literacy Score	-0.121**	-0.118*	-0.058	-0.064	-0.045	1.611*
	(0.061)	(0.065)	(0.080)	(0.087)	(0.113)	(0.849)
Highest Grade of Education	0.004	0.008	0.011	0.023	-0.028	-0.070
	(0.015)	(0.016)	(0.017)	(0.019)	(0.031)	(0.114)
Control for Plots being Managed by the Same Manager	-0.003****	-0.003****	-0.002****	-0.002****	-0.003***	-0.011**
	(0.0005)	(0.0005)	(0.0006)	(0.0007)	(0.0010)	(0.0047)
Number of Plots Managed by Same Manager	0.022	0.024	0.004	0.068	0.211	1.177
	(0.064)	(0.070)	(0.077)	(0.083)	(0.205)	(0.725)
Number of Plots Managed by Same Manager^2	-0.001	0.0003	0.001	-0.005	-0.032	-0.157**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.022)	(0.079)
Tenancy Status	-0.362**	-0.371**	-0.455**	-0.540***	-0.073	-0.197
	(0.162)	(0.169)	(0.190)	(0.207)	(0.368)	(1.147)
Disease and pest control	-0.007	0.012	0.093	0.063	-0.156	-1.496
	(0.130)	(0.136)	(0.161)	(0.177)	(0.253)	(1.071)
Organic residue management	-0.082	-0.128	-0.209	-0.254	0.163	1.516
	(0.141)	(0.151)	(0.167)	(0.188)	(0.302)	(1.174)
Irrigation	0.272	0.321*	0.456**	0.621**	0.278	-0.738
	(0.168)	(0.182)	(0.219)	(0.248)	(0.371)	(1.074)
Percent of Other Extension Services Received	0.252	0.338	0.478	0.710*	-0.065	0.293
	(0.294)	(0.322)	(0.362)	(0.415)	(0.587)	(1.566)

Table A.9 Continued: Sources of Technical Inefficiency

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Village	0***	0***	0**	0**	0**	0
	-0.00000303	-0.00000336	-0.00000367	-0.0000042	-0.00000631	-0.0000278
Total Productive Activities that the Manager Participates in		-0.048		-0.164**		0.758
		(0.061)		(0.081)		(0.495)
Level of Input in Productive Activities		-0.078		-0.065		0.987
		(0.089)		(0.113)		(0.776)
Level of Input on Income Use		-0.084		-0.070		-1.794*
		(0.075)		(0.093)		(0.774)
Percent of Assets Self-Owned		0.570**		0.305		2.405
		(0.269)		(0.413)		(1.713)
Access to Credit		0.072		-0.0559		1.620***
		(0.079)		(0.106)		(0.601)
Control over Credit		-0.046		-0.0170		-1.168**
		(0.087)		(0.123)		(0.559)
Total Groups the Manager is Highly Active in		0.010		0.018		-0.408
		(0.044)		(0.055)		(0.338)
Prevalence of Manager Having Input into All Group Decisions		-0.102		-0.174*		0.411
		(0.070)		(0.089)		(0.510)
Average of Frequency that the Manager makes decisions because						
they fear they will get in trouble		0.112		0.198		0.066
		(0.111)		(0.134)		(0.823)
how others will view their actions		0.050		0.287**		-0.830
		(0.084)		(0.114)		(0.528)
they feel it is the right thing to do		0.316		0.504*		-0.871
		(0.227)		(0.274)		(1.805)

Table A.9 Continued: Sources of Technical Inefficiency

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Household Decisions that the Manager has High Extent of Influence		0.016		-0.083		-0.057
		(0.060)		(0.078)		(0.435)
Hours Spent Farming or Fishing		-0.002		-0.030***		0.170***
		(0.008)		(0.011)		(0.058)
Hours Spent on Personal Care		0.141**		0.136		-1.279
		(0.070)		(0.083)		(0.811)
Hours Spent Cooking		-0.026		-0.063		0.254
		(0.046)		(0.107)		(0.210)
Hours Spent caring for Children or the Elderly		0.018		0.002		0.194**
		(0.019)		(0.033)		(0.086)
Hours Spent Sleeping or Resting		0.0003		-0.023		0.026
		(0.012)		(0.014)		(0.121)
N (plots)	1,159	1,159	804	804	355	355
Constant	1.429	-0.0714	0.195	-2.108	3.475*	11.91
	0.948	1.513	1.156	1.876	1.995	13.545

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.10: Sources of Technical Inefficiency from Models with Robust Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.064	————	————	————	————
	(0.115)	(0.166)	————	————	————	————
Age	-0.044	-0.036	-0.014	0.018	-0.209**	-0.822
	(0.034)	(0.036)	(0.041)	(0.042)	(0.087)	(0.557)
Age^2	0.0010	0.0010	0.0003	0.0000	0.003***	0.0110
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.007)
Literacy Score	-0.121*	-0.118*	-0.058	-0.064	-0.045	1.611
	(0.065)	(0.067)	(0.086)	(0.091)	(0.117)	(1.160)
Highest Grade of Education	0.004	0.008	0.011	0.023	-0.028	-0.070
	(0.015)	(0.016)	(0.018)	(0.019)	(0.036)	(0.151)
Control for Plots being Managed by the Same Manager	-0.003****	-0.003****	-0.002****	-0.002****	-0.003****	-0.011*
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.006)
Number of Plots Managed by Same Manager	0.022	0.024	0.004	0.068	0.211	1.177
	(0.066)	(0.071)	(0.078)	(0.077)	(0.196)	(0.719)
Number of Plots Managed by Same $Manager^2$	-0.001	0.0003	0.001	-0.005	-0.032	-0.157**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.021)	(0.073)
Tenancy Status	-0.362**	-0.371**	-0.455**	-0.540**	-0.073	-0.197
	(0.160)	(0.175)	(0.189)	(0.215)	(0.317)	(0.917)
Disease and pest control	-0.007	0.012	0.093	0.063	-0.156	-1.496
	(0.133)	(0.143)	(0.167)	(0.190)	(0.222)	(1.443)
Organic residue management	-0.082	-0.128	-0.209	-0.254	0.163	1.516
	(0.159)	(0.165)	(0.198)	(0.209)	(0.254)	(1.257)
Irrigation	0.272	0.321*	0.456*	0.621**	0.278	-0.738
	(0.173)	(0.186)	(0.238)	(0.286)	(0.304)	(1.069)

Table A.10 Cont.: Sources of Technical Inefficiency from Models with Robust Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	0.252	0.338	0.478	0.710	-0.065	0.293
	(0.335)	(0.374)	(0.444)	(0.515)	(0.495)	(1.228)
Village	0***	0***	0*	0**	0**	0**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Productive Activities that the Manager Participates in		-0.048		-0.164*		0.758
		(0.064)		(0.086)		(0.704)
Level of Input in Productive Activities		-0.078		-0.065		0.987
		(0.091)		(0.116)		(0.922)
Level of Input on Income Use		-0.084		-0.070		-1.794*
		(0.075)		(0.090)		(0.961)
Percent of Assets Self-Owned		0.570**		0.305		2.405
		(0.239)		(0.415)		(2.187)
Access to Credit		0.072		-0.056		1.620**
		(0.085)		(0.101)		(0.719)
Control over Credit		-0.046		-0.017		-1.168
		(0.091)		(0.121)		(0.733)
Total Groups the Manager is Highly Active in		0.010		0.018		-0.408
		(0.048)		(0.063)		(0.349)

Table A.10 Cont.: Sources of Technical Inefficiency from Models with Robust Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Prevalence of Manager Having Input into All Group Decisions		-0.102		-0.174*		0.411
		(0.076)		(0.100)		(0.459)
they fear they will get in trouble		0.112		0.198		0.066
		(0.113)		(0.146)		(0.871)
how others will view their actions		0.050		0.287**		-0.830*
		(0.087)		(0.114)		(0.431)
they feel it is the right thing to do		0.316		0.504*		-0.871
		(0.216)		(0.266)		(2.415)
Percent of Household Decisions that the Manager has High Extent of Influence		0.016		-0.083		-0.057
		(0.055)		(0.070)		(0.469)
Hours Spent Farming or Fishing		-0.002		-0.030***		0.170***
		(0.009)		(0.012)		(0.053)
Hours Spent on Personal Care		0.141**		0.136*		-1.279
		(0.064)		(0.080)		(1.002)
Hours Spent Cooking		-0.026		-0.063		0.254
		(0.044)		(0.100)		(0.222)
Hours Spent caring for Children or the Elderly		0.018		0.002		0.194**
		(0.017)		(0.031)		(0.096)
Hours Spent Sleeping or Resting		0.0003		-0.023		0.026
		(0.012)		(0.014)		(0.128)
N (plots)	1,159	1,159	804	804	355	355
Constant	1.429	-0.0714	0.195	-2.108	3.475*	11.91
	(0.914)	(1.460)	(1.169)	(1.907)	(1.928)	(16.866)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Robust Huber-White standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.11: Contributors of Technical Inefficiency from Model with Clustered Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.064	————	————	————	————
	(0.111)	(0.203)	————	————	————	————
Age	-0.044	-0.036	-0.014	0.018	-0.209***	-0.822
	(0.032)	(0.033)	(0.034)	(0.037)	(0.075)	(0.583)
Age^2	0.001	0.001	0.000	0.000	0.003***	0.011
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.007)
Literacy Score	-0.121*	-0.118*	-0.058	-0.064	-0.045	1.611
	(0.062)	(0.065)	(0.072)	(0.091)	(0.103)	(1.289)
Highest Grade of Education	0.004	0.008	0.011	0.023	-0.028	-0.070
	(0.013)	(0.014)	(0.015)	(0.017)	(0.040)	(0.181)
Control for Plots being Managed by the Same Manager	-0.003***	-0.003**	-0.002**	-0.002*	-0.003**	-0.011
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.008)
Number of Plots Managed by Same Manager	0.022	0.024	0.004	0.068	0.211	1.177
	(0.056)	(0.065)	(0.059)	(0.064)	(0.199)	(0.849)
Number of Plots Managed by Same $Manager^2$	-0.001	0.000	0.001	-0.005	-0.032*	-0.157*
	-0.004	(0.005)	(0.004)	(0.004)	(0.018)	(0.080)
Tenancy Status	-0.362***	-0.371***	-0.455***	-0.540***	-0.0726	-0.197
	(0.123)	(0.125)	(0.162)	(0.171)	(0.247)	(0.645)
Disease and pest control	-0.007	0.012	0.093	0.063	-0.156	-1.496
	(0.145)	(0.151)	(0.163)	(0.186)	(0.252)	(1.787)
Organic residue management	-0.082	-0.128	-0.209	-0.254	0.163	1.516
	(0.193)	(0.178)	(0.202)	(0.210)	(0.334)	(1.589)
Irrigation	0.272*	0.321**	0.456**	0.621**	0.278	-0.738
	(0.162)	(0.159)	(0.192)	(0.293)	(0.426)	(1.310)

Table A.11 Cont.: Contributors of Technical Inefficiency from Model with Clustered Standard Errors

	Full Sample		Male Managed		Female Managed	
Variable	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	0.252	0.338	0.478	0.710	-0.065	0.293
	(0.321)	(0.438)	(0.528)	(0.569)	(0.636)	(1.673)
Village	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Productive Activities that the Manager Participates in		-0.048		-0.164*		0.758
		(0.062)		(0.090)		(0.760)
Level of Input in Productive Activities		-0.078		-0.065		0.987
		(0.113)		(0.132)		(0.911)
Level of Input on Income Use		-0.084		-0.070		-1.794*
		(0.091)		(0.124)		(0.938)
Percent of Assets Self-Owned		0.570		0.305		2.405
		(0.399)		(0.454)		(2.733)
Access to Credit		0.072		-0.056		1.620**
		(0.112)		(0.144)		(0.766)
Control over Credit		-0.046		-0.017		-1.168
		(0.114)		(0.163)		(0.827)
Total Groups the Manager is Highly Active in		0.010		0.018		-0.408
		(0.057)		(0.069)		(0.371)

Table A.11 Cont.: Contributors of Technical Inefficiency from Model with Clustered Standard Errors

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Prevalence of Manager Having Input into All Group Decisions		-0.102		-0.174*		0.411
		(0.078)		(0.103)		(0.456)
they fear they will get in trouble		0.112		0.198		0.066
		(0.132)		(0.157)		(0.815)
how others will view their actions		0.050		0.287		-0.830*
		(0.123)		(0.189)		(0.485)
they feel it is the right thing to do		0.316**		0.504**		-0.871
		(0.148)		(0.198)		(2.167)
Percent of Household Decisions that the Manager has High Extent of Influence		0.016		-0.083		-0.057
		(0.070)		(0.104)		(0.510)
Hours Spent Farming or Fishing		-0.002		-0.0296		0.170**
		(0.015)		(0.020)		(0.079)
Hours Spent on Personal Care		0.141		0.136		-1.279
		(0.097)		(0.106)		(1.220)
Hours Spent Cooking		-0.026		-0.063		0.254
		(0.064)		(0.128)		(0.240)
Hours Spent caring for Children or the Elderly		0.018		0.002		0.194*
		(0.028)		(0.047)		(0.105)
Hours Spent Sleeping or Resting		0.0003		-0.023		0.026
		(0.013)		(0.018)		(0.140)
N (plots)	1,159	1,159	804	804	355	355
Constant	1.429*	-0.071	0.195	-2.108	3.475**	11.910
	(0.735)	(1.356)	(1.185)	(1.854)	(1.672)	(9.20)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Standard errors clustered at the commune level (33 total communes) in parentheses. Coefficients are rounded to the thousandths place when feasible, and to the ten-thousandths otherwise. Standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.12: Pearson Correlation Coefficients between Empowerment Metrics for the Full Sample

	Total Productive Activities that the Manager Participates in	Level of Input in Productive Activities	Level of Input on Income Use	Percent of Assets Self-Owned	Access to Credit	Control over Credit	Total Groups the Manager is Highly Active in	Prevalence of Manager Having Input into All Group Decisions	Average of Frequency that the Manager makes decisions because			Percent of Household Decisions that the Manager has High Extent of Influence	Hours Spent Farming or Fishing	Hours Spent on Personal Care	Hours Spent Cooking	Hours Spent caring for Children or the Elderly
									they fear they will get in trouble	how others will view their actions	they feel it is the right thing to do					
Total Productive Activities that the Manager Participates in	1															
Level of Input in Productive Activities	-0.0541*	1														
Level of Input on Income Use	-0.1660****	0.3050****	1													
Percent of Assets Self-Owned	-0.0010	0.1530****	0.1850****	1												
Access to Credit	0.0438	0.0333	0.0895***	0.2110****	1											
Control over Credit	0.0863***	0.0413	0.1420****	0.2360****	0.7110****	1										
Total Groups the Manager is Highly Active in	0.1490****	-0.0283	-0.0215	-0.0255	-0.0061	-0.0584**	1									
Prevalence of Manager Having Input into All Group Decisions	-0.0412	0.1130****	0.1490****	0.0050	-0.0826***	-0.1060****	0.278****	1								
Average of Frequency that the Manager makes decisions because																
they fear they will get in trouble	-0.0364	0.0666**	0.0989****	-0.0218	0.0582**	-0.0264	0.1010****	0.2040****	1							
how others will view their actions	0.0829***	-0.0932***	-0.0284	0.0484*	0.0814***	0.0883***	0.0497*	0.0784***	0.1510****	1						
they feel it is the right thing to do	0.0922***	-0.0170	-0.1340****	0.0640**	0.0252	0.0371	-0.0588**	-0.2870****	-0.3930****	-0.1600****	1					
Percent of Household Decisions that the Manager has High Extent of Influence	-0.0522*	0.0777***	0.1220****	-0.0702**	-0.0173	-0.0348	-0.0601**	0.0133	0.0055	0.0130	-0.000	1				
Hours Spent Farming or Fishing	0.0340	0.1340****	-0.0164	-0.0792***	-0.0498*	-0.0580**	-0.0475	0.0285	0.1250****	0.1390****	0.0016	0.0355	1			
Hours Spent on Personal Care	0.0436	0.0711**	0.0137	0.0024	0.0799***	0.0223	0.0475	0.1060****	0.0762***	0.0045	-0.1240****	-0.1200****	-0.0252	1		
Hours Spent Cooking	-0.0548*	-0.0452	0.2840****	0.2450****	0.1720****	0.2340****	0.0605**	-0.0691**	-0.0400	0.0798***	0.0071	-0.0746**	-0.1950****	-0.0741**	1	
Hours Spent caring for Children or the Elderly	0.0222	-0.0782***	0.0629**	-0.0239	0.1180****	0.0960***	0.0090	-0.0453	-0.0496*	-0.0290	0.0048	0.0334	-0.2260****	-0.1310****	0.1500****	1
Hours Spent Sleeping or Resting	-0.0387	0.0514*	-0.1060****	-0.0643**	0.0018	0.0197	-0.0321	-0.1080****	-0.0651**	-0.0890***	0.0531*	-0.0535*	-0.2520****	-0.0288	-0.0179	-0.104****

Notes: Estimates are rounded to the ten-thousandths place. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.13: Pearson Correlation Coefficients between Empowerment Metrics for the Male Sub-Sample

	Total Productive Activities that the Manager Participates in	Level of Input in Productive Activities	Level of Input on Income Use	Percent of Assets Self-Owned	Access to Credit	Control over Credit	Total Groups the Manager is Highly Active in	Prevalence of Manager Having Input into All Group Decisions	Average of Frequency that the Manager makes decisions because			Percent of Household Decisions that the Manager has High Extent of Influence	Hours Spent Farming or Fishing	Hours Spent on Personal Care	Hours Spent Cooking	Hours Spent caring for Children or the Elderly
									they fear they will get in trouble	how others will view their actions	they feel it is the right thing to do					
Total Productive Activities that the Manager Participates in	1															
Level of Input in Productive Activities	0.00456	1														
Level of Input on Income Use	-0.155****	0.289****	1													
Percent of Assets Self-Owned	0.0766**	-0.000505	-0.0041	1												
Access to Credit	0.0471	0.0604*	-0.0761**	0.0417	1											
Control over Credit	0.107***	0.0968***	-0.0410	0.0451	0.5930****	1										
Total Groups the Manager is Highly Active in	0.171****	-0.0279	-0.0143	-0.0395	-0.0089	-0.0056	1									
Prevalence of Manager Having Input into All Group Decisions	-0.105***	0.145****	0.2420****	-0.0527	-0.0595*	-0.0735**	0.2920****	1								
Average of Frequency that the Manager makes decisions because																
they fear they will get in trouble	-0.0548	0.0327	0.1870****	-0.0597*	0.0872**	-0.0008	0.1300****	0.2600****	1							
how others will view their actions	0.0429	-0.0310	-0.0636*	0.0069	0.1540****	0.1710****	0.0893**	0.1380****	0.1870****	1						
they feel it is the right thing to do	0.0846**	-0.0114	-0.1860****	0.1060***	-0.0264	0.0159	-0.1290****	-0.3900****	-0.3580****	-0.2180****	1					
Percent of Household Decisions that the Manager has High Extent of Influence	-0.103***	0.0336	0.1290****	-0.1000***	-0.0302	-0.0355	-0.0900**	-0.0151	-0.0059	0.0813**	-0.0093	1				
Hours Spent Farming or Fishing	0.00787	0.180****	0.0974***	-0.0832**	0.0058	0.0229	-0.0324	0.0119	0.1270****	0.1830****	-0.0388	0.0233	1			
Hours Spent on Personal Care	0.0800**	0.0711**	0.0073	0.0083	0.0883**	0.0145	0.0506	0.0873**	0.0276	0.0021	-0.1150***	-0.1510****	-0.0216	1		
Hours Spent Cooking	0.0761**	-0.0327	0.0270	0.0734**	0.0860**	0.1920****	0.0779**	-0.0203	0.1260****	0.0353	-0.0507	-0.0598*	-0.0296	-0.1930****	1	
Hours Spent caring for Children or the Elderly	0.0179	-0.0795**	-0.0145	-0.0332	-0.0550	-0.1090***	0.0830**	-0.0432	-0.0159	-0.0621*	0.0440	-0.0460	-0.1050***	-0.1150***	0.1540****	1
Hours Spent Sleeping or Resting	-0.0333	-0.0512	-0.1970****	-0.1030***	0.0407	0.0471	-0.0895**	-0.0979***	-0.0816**	-0.0889**	0.0733**	-0.1020***	-0.2800****	-0.0711**	-0.0543	-0.0689*

Notes: Estimates are rounded to the ten-thousandths place. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.14: Pearson Correlation Coefficients between Empowerment Metrics for the Female Sub-Sample

									Average of Frequency that the Manager makes decisions because								
	Total Productive Activities that the Manager Participates in	Level of Input in Productive Activities	Level of Input on Income Use	Percent of Assets Self-Owned	Access to Credit	Control over Credit	Total Groups the Manager is Highly Active in	Prevalence of Manager Having Input into All Group Decisions	they fear they will get in trouble	how others will view their actions	they feel it is the right thing to do	Percent of Household Decisions that the Manager has High Extent of Influence	Hours Spent Farming or Fishing	Hours Spent on Personal Care	Hours Spent Cooking	Hours Spent caring for Children or the Elderly
Total Productive Activities that the Manager Participates in	1																
Level of Input in Productive Activities	-0.1570***	1															
Level of Input on Income Use	-0.1170**	0.4650****	1														
Percent of Assets Self-Owned	-0.0592	0.3340****	0.2560****	1													
Access to Credit	0.0840	0.0030	0.1780****	0.2840****	1												
Control over Credit	0.1190**	-0.0131	0.2130****	0.2930****	0.7960****	1											
Total Groups the Manager is Highly Active in	0.1110**	-0.0291	-0.0411	-0.0110	-0.0009	-0.1250**	1										
Prevalence of Manager Having Input into All Group Decisions	0.0840	0.0453	0.0504	0.1360**	-0.0960*	-0.1330**	0.2510****	1									
Average of Frequency that the Manager makes decisions because																	
they fear they will get in trouble	-0.0185	0.1390***	0.0144	0.0775	0.0594	-0.0212	0.0351	0.0286	1								
how others will view their actions	0.1750****	-0.2010****	-0.0505	0.0670	-0.0437	-0.0347	-0.0231	-0.0442	0.0879*	1							
they feel it is the right thing to do	0.1220**	-0.0308	-0.0498	0.0048	0.1170**	0.0691	0.1170**	0.0416	-0.5010****	-0.0199	1						
Percent of Household Decisions that the Manager has High Extent of Influence	0.0447	0.1530***	0.1200**	-0.0564	-0.0093	-0.0478	-0.0049	0.0840	0.0363	-0.1180**	0.0220	1					
Hours Spent Farming or Fishing	0.0448	0.0439	-0.0450	0.0243	-0.0564	-0.0810	-0.0879*	0.0296	0.0746	0.0844	0.1420***	0.0771	1				
Hours Spent on Personal Care	-0.0627	0.0731	0.1730***	0.0422	0.1170**	0.0841	0.0408	0.1470***	0.2000****	0.0255	-0.1480***	-0.0429	-0.0876*	1			
Hours Spent Cooking	-0.0405	-0.0800	-0.0075	0.1210**	0.0492	0.0773	0.1090**	-0.0479	-0.0663	0.0731	0.0305	-0.1830****	-0.2050****	0.0870	1		
Hours Spent caring for Children or the Elderly	0.0677	-0.0835	-0.0401	-0.1080**	0.1870****	0.1540***	-0.0610	-0.0243	-0.0637	-0.0274	-0.0567	0.1090**	-0.3500****	-0.1530***	-0.0331	1	
Hours Spent Sleeping or Resting	-0.0610	0.2720****	0.1910****	-0.0046	-0.0494	0.0013	0.0990*	-0.1480***	-0.0279	-0.0854	-0.0081	0.0602	-0.2100****	0.0902*	0.0521	-0.1580***	

Notes: Estimates are rounded to the ten-thousandths place. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.15: Stochastic Production Frontier Estimates with Empowerment Metrics Dropped

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096***	1.202****	1.140***	1.256****	1.502**	1.559**
	(0.356)	(0.351)	(0.382)	(0.378)	(0.726)	(0.737)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.106	0.078	-0.036	-0.655	-0.794
	(0.340)	(0.337)	(0.337)	(0.343)	(0.679)	(0.711)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.003	0.002	-0.003	-0.008	-0.007
	(0.012)	(0.012)	(0.014)	(0.014)	(0.022)	(0.021)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.052****	0.077***	0.080****
	(0.012)	(0.013)	(0.015)	(0.015)	(0.024)	(0.024)
Quantity of Pesticide (Pest) (kg)	0.043	0.042	0.067**	0.059*	0.008	0.022
	(0.028)	(0.028)	(0.032)	(0.032)	(0.055)	(0.056)
Number of Hired Laborers (Labor)	-0.252****	-0.266****	-0.217****	-0.223****	-0.327***	-0.282**
	(0.056)	(0.056)	(0.063)	(0.062)	(0.118)	(0.120)
1/2 Land^2	0.088	0.113	0.104	0.134	0.108	0.113
	(0.092)	(0.091)	(0.107)	(0.107)	(0.178)	(0.178)
1/2 Seed^2	-0.009	0.014	-0.036	-0.012	0.164	0.186
	(0.075)	(0.074)	(0.074)	(0.075)	(0.147)	(0.153)
1/2 Bfert^2	0.009	0.009	0.007	0.007	0.004	0.010
	(0.007)	(0.007)	(0.008)	(0.008)	(0.012)	(0.012)
1/2 Tfert^2	0.015***	0.016***	0.010	0.010	0.024***	0.025***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.009)
1/2 Pest^2	-0.009	-0.008	-0.000	-0.001	-0.022	-0.020
	(0.008)	(0.008)	(0.009)	(0.009)	(0.014)	(0.014)
1/2 labor^2	0.133****	0.139****	0.112****	0.117****	0.196****	0.173***
	(0.026)	(0.026)	(0.028)	(0.029)	(0.054)	(0.058)

Table A.15 Cont.: Stochastic Production Frontier Estimates with Empowerment Metrics Dropped

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Seed	-0.017	-0.040	0.006	-0.016	-0.190	-0.200
	(0.073)	(0.072)	(0.076)	(0.076)	(0.145)	(0.147)
Land X Bfert	-0.004	-0.004	-0.003	-0.003	-0.002	-0.005
	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)
Land X Tfert	0.003	0.003	0.006	0.005	-0.002	-0.003
	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)
Land X Pest	0.029****	0.028****	0.031***	0.030***	0.026**	0.026**
	(0.008)	(0.008)	(0.010)	(0.010)	(0.013)	(0.013)
Land X Labor	-0.086****	-0.089****	-0.100****	-0.106****	-0.060	-0.060*
	(0.023)	(0.024)	(0.028)	(0.029)	(0.037)	(0.035)
Labor X Bfert	0.006**	0.007**	0.005	0.006**	0.011**	0.014***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
Labor X Tfert	-0.010***	-0.010***	-0.009**	-0.009**	-0.009	-0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)
Labor X Pest	-0.012**	-0.012**	-0.011*	-0.009	-0.013	-0.015
	(0.005)	(0.005)	(0.006)	(0.006)	(0.012)	(0.013)
Temperature (C°)	0.354****	0.351****	0.372****	0.372****	0.477****	0.397**
	(0.077)	(0.079)	(0.092)	(0.096)	(0.140)	(0.169)
Rainfall (mm)	-0.0007****	-0.0006***	-0.0007***	-0.0007***	-0.0008**	-0.0005
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0004)
Constant	-1.175	-0.890	-1.542	-1.316	-3.453	-1.428
	(2.350)	(2.407)	(2.749)	(2.895)	(4.157)	(4.956)
σ_v^2	-2.580****	-2.542****	-2.674****	-2.597****	-2.487****	-2.341****
	(0.132)	(0.135)	(0.165)	(0.171)	(0.263)	(0.324)
N (plots)	1159	1159	804	804	355	355
Log-psuedolikelihood	-766.154	-757.776	-533.284	-522.060	-206.473	-193.269
Bayesian Information Criterion (BIC)	1807.466	1882.429	1320.772	1385.290	636.086	686.016
Wald $\chi^2(22)$	4331.060****	4181.260****	3185.640****	2969.930****	1792.420****	1955.450****

Notes: The model did not converge for the female sub-sample after the empowerment metrics were added. Robust Huber-White standard errors are in parentheses. Coefficients are rounded to the thousandths place when feasible. Standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.16: Sources of Technical Inefficiency from Models with Empowerment Metrics Dropped

Variable	Full Sample		Male Managed		Male Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.053	0	0	0	0
	(0.115)	(0.174)	----	----	----	----
Age	-0.044	-0.036	-0.014	0.012	-0.209**	-0.282**
	(0.034)	(0.035)	(0.041)	(0.041)	(0.087)	(0.126)
Age^2	0.001	0.000	0.000	0.000	0.003***	0.003**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Literacy Score	-0.121*	-0.121*	-0.058	-0.045	-0.045	0.023
	(0.065)	(0.067)	(0.086)	(0.090)	(0.117)	(0.189)
Highest Grade of Education	0.004	0.008	0.011	0.021	-0.028	-0.061*
	(0.015)	(0.016)	(0.018)	(0.019)	(0.036)	(0.035)
Control for Plots being Managed by the Same Manager	-0.003****	-0.002****	-0.002****	-0.002****	-0.003****	-0.003***
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Number of Plots Managed by Same Manager	0.022	0.011	0.004	0.036	0.211	0.236
	(0.066)	(0.072)	(0.078)	(0.082)	(0.196)	(0.272)
Number of Plots Managed by Same $Manager^2$	-0.001	0.001	0.001	-0.002	-0.032	-0.039
	(0.005)	(0.006)	(0.006)	(0.006)	(0.021)	(0.030)
Tenancy Status	-0.362**	-0.380**	-0.455**	-0.551**	-0.073	0.220
	(0.160)	(0.172)	(0.189)	(0.215)	(0.317)	(0.331)
Disease and pest control	-0.007	0.017	0.093	0.071	-0.156	-0.215
	(0.133)	(0.143)	(0.167)	(0.189)	(0.222)	(0.266)
Organic residue management	-0.082	-0.140	-0.209	-0.328	0.163	0.265
	(0.159)	(0.167)	(0.198)	(0.213)	(0.254)	(0.406)
Irrigation	0.272	0.312*	0.456*	0.554**	0.278	0.343
	(0.173)	(0.185)	(0.238)	(0.277)	(0.304)	(0.377)

Table A.16 Cont.: Sources of Technical Inefficiency from Models with Empowerment Metrics Dropped

	Full Sample		Male Managed		Female Managed	
Variable	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	0.252	0.398	0.478	0.601	-0.065	0.253
	(0.335)	(0.366)	(0.444)	(0.491)	(0.495)	(0.699)
Village	0.000***	0.000***	0.000*	0.000*	0.000**	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Productive Activities that the Manager Participates in		-0.039		-0.132		0.169
		(0.064)		(0.085)		(0.175)
Level of Input in Productive Activities		-0.071		-0.052		0.010
		(0.089)		(0.112)		(0.206)
Level of Input on Income Use		-0.102		-0.128		-0.410*
		(0.073)		(0.086)		(0.247)
Percent of Assets Self-Owned		0.587**		0.385		0.755*
		(0.236)		(0.395)		(0.451)
Control over Credit		0.024		0.014		0.043
		(0.055)		(0.098)		(0.097)

Table A.16 Cont.: Sources of Technical Inefficiency from Models with Empowerment Metrics Dropped

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Prevalence of Manager Having Input into All Group Decisions		-0.123*		-0.189*		0.005
		(0.073)		(0.100)		(0.131)
Average of Frequency that the Manager makes decisions because						
they fear they will get in trouble		0.070		0.167		-0.106
		(0.103)		(0.135)		(0.219)
Percent of Household Decisions that the Manager has High Extent of Influence		0.019		-0.065		0.214
		(0.055)		(0.069)		(0.132)
Hours Spent Farming or Fishing		-0.001		-0.023**		0.085**
		(0.009)		(0.011)		(0.033)
Hours Spent on Personal Care		0.137**		0.123		0.073
		(0.063)		(0.078)		(0.186)
Hours Spent Cooking		-0.026		-0.032		0.001
		(0.046)		(0.106)		(0.060)
Hours Spent caring for Children or the Elderly		0.020		0.011		0.083*
		(0.017)		(0.031)		(0.048)
Hours Spent Sleeping or Resting		0.001		-0.018		0.056
		(0.013)		(0.016)		(0.046)
N (plots)	1159	1159	804	804	355	355
Constant	1.429	1.360	0.195	0.576	3.475*	2.588
	(0.914)	(1.142)	(1.169)	(1.447)	(1.928)	(2.918)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Robust Huber-White standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.17: Stochastic Production Frontier Estimates with and without WEAI Indexed Score

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096***	1.128***	1.140***	1.168***	1.502**	1.544**
	(0.356)	(0.353)	(0.382)	(0.376)	(0.726)	(0.710)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.016	0.078	0.057	-0.655	-0.663
	(0.340)	(0.335)	(0.337)	(0.330)	(0.679)	(0.671)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.006	0.002	0.005	-0.008	-0.008
	(0.0120)	(0.012)	(0.014)	(0.014)	(0.022)	(0.022)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.065****	0.067****	0.054****	0.057****	0.077***	0.078****
	(0.012)	(0.012)	(0.015)	(0.015)	(0.024)	(0.023)
Quantity of Pesticide (Pest) (kg)	0.043	0.046	0.067**	0.073**	0.008	0.008
	(0.028)	(0.028)	(0.032)	(0.032)	(0.055)	(0.054)
Number of Hired Laborers (Labor)	-0.252****	-0.258****	-0.217****	-0.227****	-0.327***	-0.335***
	(0.056)	(0.057)	(0.063)	(0.064)	(0.118)	(0.118)
1/2 Land^2	0.088	0.098	0.104	0.113	0.108	0.125
	(0.092)	(0.092)	(0.107)	(0.106)	(0.178)	(0.174)
1/2 Seed^2	-0.009	-0.006	-0.036	-0.033	0.164	0.165
	(0.075)	(0.074)	(0.074)	(0.073)	(0.147)	(0.146)
1/2 Bfert^2	0.009	0.011	0.007	0.01	0.004	0.003
	(0.007)	(0.007)	(0.008)	(0.008)	(0.012)	(0.012)
1/2 Tfert^2	0.015***	0.015***	0.01	0.009	0.024***	0.026***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.008)
1/2 Pest^2	-0.009	-0.008	-0.000	0.000	-0.022	-0.021
	(0.008)	(0.008)	(0.009)	(0.009)	(0.014)	(0.014)
1/2 labor^2	0.133****	0.135****	0.112****	0.116****	0.196****	0.202****
	(0.026)	(0.026)	(0.028)	(0.029)	(0.054)	(0.054)

Table A.17 Continued: Stochastic Production Frontier Estimates with and without WEAI Indexed Score

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Seed	-0.017	-0.025	0.006	-0.001	-0.190	-0.198
	(0.073)	(0.072)	(0.076)	(0.075)	(0.145)	(0.142)
Land X Bfert	-0.004	-0.005	-0.003	-0.004	-0.002	-0.001
	(0.005)	(0.005)	(0.006)	(0.005)	(0.007)	(0.007)
Land X Tfert	0.003	0.004	0.006	0.007	-0.002	-0.003
	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)
Land X Pest	0.029****	0.030****	0.031***	0.032***	0.026**	0.026**
	(0.008)	(0.008)	(0.01)	(0.01)	(0.013)	(0.013)
Land X Labor	-0.086****	-0.085****	-0.100****	-0.099****	-0.06	-0.062*
	(0.023)	(0.024)	(0.028)	(0.028)	(0.037)	(0.036)
Labor X Bfert	0.006**	0.006**	0.005	0.005	0.011**	0.011**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
Labor X Tfert	-0.01***	-0.011***	-0.009**	-0.011**	-0.009	-0.009
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)
Labor X Pest	-0.012**	-0.013**	-0.011*	-0.012**	-0.013	-0.013
	(0.005)	(0.005)	(0.006)	(0.006)	(0.012)	(0.012)
Temperature (C°)	0.354****	0.358****	0.372****	0.377****	0.477****	0.480****
	(0.077)	(0.077)	(0.092)	(0.092)	(0.140)	(0.139)
Rainfall (mm)	-0.001****	-0.001***	-0.001***	-0.001***	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.175	-1.313	-1.542	-1.736	-3.453	-3.571
	(2.350)	(2.356)	(2.749)	(2.746)	(4.157)	(4.115)
σ_v	-2.580****	-2.572****	-2.674****	-2.659****	-2.487****	-2.514****
	(0.132)	(0.130)	(0.165)	(0.164)	(0.263)	(0.252)
N (plots)	1,159	1,159	804	804	355	355
Log-Likelihood	-766.154	-753.026	-533.284	-520.358	-206.473	-205.455
Bayesian Information Criterion (BIC)	1807.466	1787.052	1320.772	1301.025	636.086	639.924

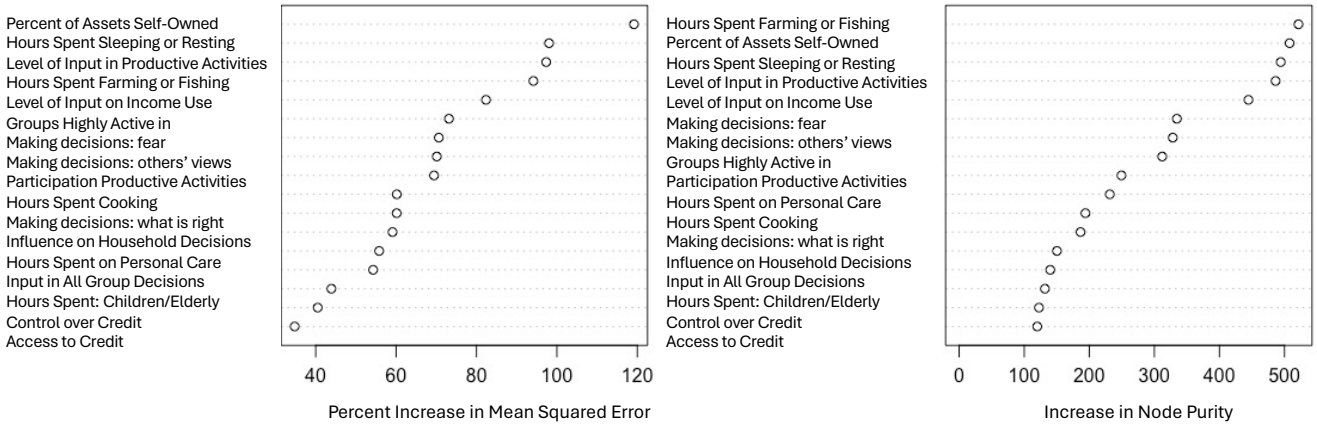
Notes: The model did not converge for the female sub-sample after the empowerment metrics were added. Coefficients are rounded to the thousandths place when feasible. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.18: Contributors of Technical Inefficiency from Models with WEAI Indexed Score

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.117	0	0	0	0
	(0.115)	(0.116)	(.)	(.)	(.)	(.)
Age	-0.044	-0.044	-0.014	-0.008	-0.209**	-0.229***
	(0.034)	(0.036)	(0.041)	(0.044)	(0.087)	(0.086)
Age^2	0.001	0.001	0.000	0.000	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Literacy Score	-0.121*	-0.123*	-0.058	-0.042	-0.045	-0.038
	(0.065)	(0.066)	(0.086)	(0.094)	(0.117)	(0.116)
Highest Grade of Education	0.004	0.007	0.011	0.015	-0.028	-0.022
	(0.015)	(0.015)	(0.018)	(0.018)	(0.036)	(0.037)
Control for Plots being Managed by the Same Manager	-0.003****	-0.003****	-0.002****	-0.003****	-0.003****	-0.003****
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Number of Plots Managed by Same Manager	0.0222	0.0460	0.00408	0.0361	0.211	0.233
	(0.066)	(0.067)	(0.078)	(0.079)	(0.196)	(0.187)
Number of Plots Managed by Same Manager^2	-0.000884	-0.00238	0.000539	-0.00137	-0.0316	-0.0326*
	(0.005)	(0.005)	(0.006)	(0.006)	(0.021)	(0.02)
Tenancy Status	-0.362**	-0.371**	-0.455**	-0.475**	-0.073	-0.068
	(0.160)	(0.160)	(0.189)	(0.191)	(0.317)	(0.311)
Disease and pest control	-0.007	0.016	0.093	0.138	-0.156	-0.191
	(0.133)	(0.135)	(0.167)	(0.171)	(0.222)	(0.218)
Organic residue management	-0.082	-0.045	-0.209	-0.166	0.163	0.194
	(0.159)	(0.163)	(0.198)	(0.204)	(0.254)	(0.250)
Irrigation	0.272	0.215	0.456*	0.379	0.278	0.311
	(0.173)	(0.174)	(0.238)	(0.243)	(0.304)	(0.294)
Percent of Other Extension Services Received	0.252	0.347	0.478	0.623	-0.065	-0.046
	(0.335)	(0.335)	(0.444)	(0.438)	(0.495)	(0.480)
Village	0.000***	0.000***	0.000*	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
WEAI Score		-1.011		-1.080		-1.764*
		(0.643)		(0.868)		(0.949)
N (plots)	1,159	1,159	804	792	355	355
Constant	1.429	2.293*	0.195	0.880	3.475*	5.353**
	(0.914)	(1.185)	(1.169)	(1.571)	(1.928)	(2.159)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Coefficients are rounded to the thousandths place. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Appendix 19: Variable Importance in Predicting Harvest Output



Notes: The figure reports the relative importance of each empowerment dimension in predicting agricultural output, measured by percent increase in mean squared error (%IncMSE) and increase in node purity (IncNodePurity). Higher values indicate stronger predictive contribution. Across both measures, five dimensions consistently stand out as most influential: percent of assets self-owned, hours spent sleeping or resting, level of input in productive activities, hours spent farming or fishing, and level of input on income use. The clear separation between these top five dimensions and the remaining measures suggests that empowerment's predictive power is concentrated in a small subset of indicators.

Table A.20: Stochastic Production Frontier Estimates with Top 5 Influential Empowerment Dimensions

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area (Land) (ha)	1.096***	1.145***	1.140***	1.147***	1.502**	1.697**
	(0.356)	(0.352)	(0.382)	(0.375)	(0.726)	(0.725)
Quantity of Improved Seed (Seed) (kg)	0.005	-0.044	0.078	0.052	-0.655	-0.869
	(0.340)	(0.338)	(0.337)	(0.341)	(0.679)	(0.693)
Quantity of Basal Fertilizer (Bfert) (kg)	0.004	0.004	0.002	-0.002	-0.008	-0.007
	(0.012)	(0.012)	(0.014)	(0.014)	(0.022)	(0.021)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.065****	0.065****	0.054****	0.052****	0.077***	0.083****
	(0.012)	(0.012)	(0.015)	(0.015)	(0.024)	(0.023)
Quantity of Pesticide (Pest) (kg)	0.043	0.044	0.067**	0.065**	0.008	0.021
	(0.028)	(0.028)	(0.032)	(0.032)	(0.055)	(0.056)
Number of Hired Laborers (Labor)	-0.252****	-0.259****	-0.217****	-0.227****	-0.327***	-0.290**
	(0.056)	(0.056)	(0.063)	(0.063)	(0.118)	(0.116)
1/2 Land^2	0.088	0.098	0.104	0.101	0.108	0.163
	(0.092)	(0.091)	(0.107)	(0.106)	(0.178)	(0.174)
1/2 Seed^2	-0.009	0.001	-0.036	-0.031	0.164	0.204
	(0.075)	(0.074)	(0.074)	(0.075)	(0.147)	(0.149)
1/2 Bfert^2	0.009	0.009	0.007	0.006	0.004	0.006
	(0.007)	(0.007)	(0.008)	(0.008)	(0.012)	(0.012)
1/2 Tfert^2	0.015***	0.015***	0.01	0.01	0.024***	0.027***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.009)	(0.009)
1/2 Pest^2	-0.009	-0.008	-0.00	-0.00	-0.022	-0.018
	(0.008)	(0.008)	(0.009)	(0.009)	(0.014)	(0.014)
1/2 labor^2	0.133****	0.135****	0.112****	0.117****	0.196****	0.186****
	(0.026)	(0.026)	(0.028)	(0.029)	(0.054)	(0.053)

Table A.20 Continued: Stochastic Production Frontier Estimates with Top 5 Influential Empowerment Dimensions

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Land X Seed	-0.017	-0.027	0.006	0.006	-0.190	-0.231
	(0.073)	(0.072)	(0.076)	(0.075)	(0.145)	(0.144)
Land X Bfert	-0.004	-0.004	-0.003	-0.003	-0.002	-0.004
	(0.005)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)
Land X Tfert	0.003	0.003	0.006	0.006	-0.002	-0.002
	(0.005)	(0.005)	(0.006)	(0.006)	(0.009)	(0.009)
Land X Pest	0.029****	0.029****	0.031***	0.031***	0.026**	0.024*
	(0.008)	(0.008)	(0.01)	(0.01)	(0.013)	(0.013)
Land X Labor	-0.086****	-0.087****	-0.100****	-0.103****	-0.06	-0.06*
	(0.023)	(0.023)	(0.028)	(0.029)	(0.037)	(0.036)
Labor X Bfert	0.006**	0.007**	0.005	0.006*	0.011**	0.012**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
Labor X Tfert	-0.01***	-0.01***	-0.01**	-0.01**	-0.009	-0.01
	(0.004)	(0.004)	(0.004)	(0.004)	(0.008)	(0.008)
Labor X Pest	-0.012**	-0.012**	-0.011*	-0.010*	-0.013	-0.012
	(0.005)	(0.005)	(0.006)	(0.006)	(0.012)	(0.013)
Temperature (C°)	0.354****	0.347****	0.372****	0.360****	0.477****	0.369**
	(0.077)	(0.078)	(0.092)	(0.093)	(0.140)	(0.156)
Rainfall (mm)	-0.001****	-0.001***	-0.001***	-0.001***	-0.001**	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.175	-0.893	-1.542	-1.122	-3.453	-0.242
	(2.350)	(2.367)	(2.749)	(2.798)	(4.157)	(4.588)
σ_v	-2.580****	-2.551****	-2.674****	-2.606****	-2.487****	-2.367****
	(0.132)	(0.133)	(0.165)	(0.174)	(0.263)	(0.330)
N (plots)	1,159	1,159	804	804	355	355
Log-Likelihood	-766.154	-762.423	-533.284	-520.213	-206.473	-199.276
Bayesian Information Criterion (BIC)	1807.466	1835.28	1320.772	1344.078	636.086	651.053

Notes: The model did not converge for the female sub-sample after the empowerment metrics were added. Coefficients are rounded to the thousandths place when feasible. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.21: Contributors of Technical Inefficiency from Model with Top 5 Influential Empowerment Dimensions

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	-0.112	-0.096	0	0	0	0
	(0.115)	(0.132)	(.)	(.)	(.)	(.)
Age	-0.044	-0.039	-0.014	-0.014	-0.209**	-0.269**
	(0.034)	(0.035)	(0.041)	(0.045)	(0.087)	(0.115)
Age^2	0.001	0.001	0.000	0.000	0.003***	0.003**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Literacy Score	-0.121*	-0.103	-0.058	-0.049	-0.045	-0.003
	(0.065)	(0.065)	(0.086)	(0.088)	(0.117)	(0.135)
Highest Grade of Education	0.004	0.009	0.011	0.017	-0.028	-0.047
	(0.015)	(0.016)	(0.018)	(0.019)	(0.036)	(0.034)
Control for Plots being Managed by the Same Manager	-0.003****	-0.003****	-0.002****	-0.002****	-0.003****	-0.003****
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Number of Plots Managed by Same Manager	0.022	0.02	0.004	0.028	0.211	0.219
	(0.066)	(0.07)	(0.078)	(0.079)	(0.196)	(0.237)
Number of Plots Managed by Same $Manager^2$	-0.001	-0.000	0.001	-0.001	-0.032	-0.032
	(0.005)	(0.005)	(0.006)	(0.006)	(0.021)	(0.028)
Tenancy Status	-0.362**	-0.375**	-0.455**	-0.516***	-0.073	0.056
	(0.160)	(0.166)	(0.189)	(0.196)	(0.317)	(0.338)
Disease and pest control	-0.007	-0.024	0.093	0.048	-0.156	-0.099
	(0.133)	(0.136)	(0.167)	(0.175)	(0.222)	(0.287)
Organic residue management	-0.082	-0.093	-0.209	-0.310	0.163	0.261
	(0.159)	(0.160)	(0.198)	(0.201)	(0.254)	(0.316)
Irrigation	0.272	0.273	0.456*	0.503*	0.278	0.319
	(0.173)	(0.178)	(0.238)	(0.261)	(0.304)	(0.349)

Table A.21 Continued: Contributors of Technical Inefficiency from Model with Top 5 Influential Empowerment Dimensions

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	0.252	0.233	0.478	0.404	-0.0646	0.152
	(0.335)	(0.340)	(0.444)	(0.442)	(0.495)	(0.575)
Village	0.000***	0.000***	0.000*	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Level of Input in Productive Activites		-0.074		-0.075		0.012
		(0.085)		(0.106)		(0.196)
Level of Input on Income Use		-0.096		-0.143*		-0.315
		(0.07)		(0.083)		(0.202)
Percent of Assets Self-Owned		0.534**		0.308		0.664
		(0.226)		(0.376)		(0.411)
Hours Spent Farming or Fishing		-0.001		-0.02*		0.056***
		(0.008)		(0.011)		(0.021)
Hours Spent Sleeping or Resting		-0.001		-0.017		0.025
		(0.012)		(0.015)		(0.029)
N (plots)	1,159	1,159	804	804	355	355
Constant	1.429*	-0.071	0.195	-2.108	3.475**	11.910
	(0.735)	(1.356)	(1.185)	(1.854)	(1.672)	(15.880)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Coefficients are rounded to the thousandths place when feasible, and to the ten-thousandths otherwise. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.22: Stochastic Production Frontier Estimates with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Harvested Land Area (Harv)	1.049***	1.160***	1.036***	1.163***	1.567**	2.057***
	(0.361)	(0.356)	(0.379)	(0.372)	(0.743)	(0.660)
Quantity of Improved Seed (Seed)	0.017	-0.091	0.0865	-0.0189	-0.566	-1.134*
	(0.348)	(0.343)	(0.346)	(0.346)	(0.696)	(0.640)
Quantity of Basal Fertilizer (Bfert)	-0.004	-0.004	-0.005	-0.012	-0.020	-0.027
	(0.0128)	(0.0128)	(0.0156)	(0.0158)	(0.0251)	(0.0232)
Quantity of Top Dressing Fertilizer (Tfert)	0.053****	0.053****	0.039**	0.033*	0.073***	0.067***
	(0.0138)	(0.0139)	(0.0163)	(0.0170)	(0.0257)	(0.0254)
Quantity of Pesticide (Pest)	0.039	0.034	0.077**	0.057*	0.018	0.038
	(0.0303)	(0.0301)	(0.0347)	(0.0341)	(0.0671)	(0.0558)
Number of Hired Laborers (Labor)	-0.247****	-0.253****	-0.214****	-0.197***	-0.239**	-0.254**
	(0.055)	(0.056)	(0.062)	(0.061)	(0.116)	(0.107)
1/2 Harv^2	0.069	0.096	0.0656	0.0949	0.124	0.268*
	(0.095)	(0.094)	(0.103)	(0.102)	(0.189)	(0.161)
1/2 Seed^2	-0.012	0.011	-0.037	-0.016	0.139	0.260*
	(0.078)	(0.076)	(0.0768)	(0.0768)	(0.153)	(0.139)
1/2 Bfert^2	0.008	0.009	0.006	0.004	0.010	0.003
	(0.00744)	(0.00749)	(0.00870)	(0.00892)	(0.0147)	(0.0129)
1/2 Tfert^2	0.011	0.011	0.007	0.007	0.005	0.018**
	(0.00667)	(0.00675)	(0.00835)	(0.00853)	(0.0145)	(0.00878)
1/2 Pest^2	-0.010	-0.011	0.00147	-0.00133	-0.0153	-0.0150
	(0.00817)	(0.00814)	(0.00935)	(0.00934)	(0.0179)	(0.0140)
1/2 labor^2	0.130****	0.133****	0.111****	0.107****	0.157***	0.154***
	(0.0258)	(0.0262)	(0.0292)	(0.0295)	(0.0542)	(0.0528)

Table A.22 Cont.: Stochastic Production Frontier Estimates with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(5)	(6)
Harv X Seed	-0.007	-0.030	0.0297	0.00857	-0.198	-0.288**
	(0.0754)	(0.0740)	(0.0756)	(0.0745)	(0.148)	(0.130)
Harv X Bfert	-0.004	-0.004	-0.00160	-0.00220	-0.00457	-0.00397
	(0.00481)	(0.00481)	(0.00575)	(0.00585)	(0.00750)	(0.00716)
Harv X Tfert	0.003	0.002	0.00535	0.00281	0.00701	-0.00259
	(0.00514)	(0.00515)	(0.00627)	(0.00629)	(0.0106)	(0.00930)
Harv X Pest	0.029****	0.028****	0.0318***	0.0306***	0.0279**	0.0284**
	(0.00798)	(0.00801)	(0.0106)	(0.0108)	(0.0134)	(0.0131)
Harv X Labor	-0.090****	-0.091****	-0.102****	-0.105****	-0.0475	-0.0695*
	(0.0231)	(0.0232)	(0.0290)	(0.0295)	(0.0403)	(0.0366)
Labor X Bfert	0.007***	0.007***	0.00514	0.00675**	0.0139**	0.0165***
	(0.00264)	(0.00264)	(0.00322)	(0.00319)	(0.00550)	(0.00505)
Labor X Tfert	-0.009**	-0.009**	-0.00784*	-0.00540	-0.0131	-0.00598
	(0.00367)	(0.00365)	(0.00411)	(0.00415)	(0.00911)	(0.00861)
Labor X Pest	-0.012**	-0.011**	-0.0103*	-0.00618	-0.0103	-0.0179
	(0.00530)	(0.00534)	(0.00606)	(0.00598)	(0.0123)	(0.0134)
Temperature (C°)	0.354****	0.363****	0.403****	0.406****	0.351**	0.288**
	(0.0787)	(0.0812)	(0.0933)	(0.0972)	(0.153)	(0.118)
Rainfall (mm)	-0.0007***	-0.0006***	-0.0007***	-0.000653***	-0.000658	-0.000171
	(0.000208)	(0.000216)	(0.000245)	(0.000250)	(0.000413)	(0.000294)
Constant	-1.140	-1.224	-2.307	-2.342	0.560	1.310
	(2.398)	(2.466)	(2.816)	(2.947)	(4.213)	(5.058)
σ_v	0.280	0.286	0.276	0.291	0.300	0.371
	0.018	0.019	0.022	0.024	0.037	0.015
Log-pseudolikelihood	-755.526	-745.251	-521.456	-508.539	-200.691	-167.821
Bayesian Information Criterion (BIC)	1884.984	1984.376	1390.771	1471.971	694.988	711.457
Wald 〖 χ〗 ^2 (22)	2436.970****	2411.080****	1747.880****	1697.170****	881.970****	1604.810****
Log-Likelihood Ratio Test Statistic	20.55		25.830*		65.74****	

Notes: Fourth quartile dropped due to dummy variable trap. Quartile for land area dropped in gendered sub-samples due to multicollinearity. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Asymptotic standard errors were first used to calculate log likelihood ratio test statistic. Robust Huber-white standard errors are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.23: Marginal Elasticities of Inputs at the Mean for Models with Quartile Variables

Input	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Land Area (Land) (ha)	-0.0908***	-0.1010***	-0.0821***	-0.0926***	-0.164**	-0.225***
	(0.0312)	(0.0308)	(0.0300)	(0.0297)	(0.0769)	(0.0720)
Quantity of Improved Seed (Seed) (kg)	0.0093	-0.0511	0.0493	-0.0108	-0.312	-0.654*
	(0.1950)	(0.1930)	(0.1970)	(0.1980)	(0.3830)	(0.3690)
Quantity of Basal Fertilizer (Bfert) (kg)	0.0006	0.0006	0.000508	0.00137	0.00431	0.00615
	(0.0018)	(0.0018)	(0.0017)	(0.0018)	(0.0054)	(0.0052)
Quantity of Top Dressing Fertilizer (Tfert) (kg)	0.0017****	0.0017****	0.00116**	0.000969*	0.00269***	0.00256***
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0010)	(0.0010)
Quantity of Pesticide (Pest) (kg)	-0.0226	-0.0197	-0.0436**	-0.0325*	-0.0109	-0.0246
	(0.0176)	(0.0175)	(0.0196)	(0.0194)	(0.0418)	(0.0364)
Number of Hired Laborers (Labor)	-0.0699****	-0.0720****	-0.0610****	-0.0563***	-0.0679**	-0.0755**
	(0.0156)	(0.0158)	(0.0178)	(0.0176)	(0.0330)	(0.0319)
N (plots)	1,159	1,159	804	804	355	355

Notes: Coefficients are rounded to the ten-thousandths. t-statistics are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. **** p<0.001

Table A.24: Sources of Technical Inefficiency from Models with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Gender	0.013	0.088	____	____	____	____
	(0.127)	(0.182)	____	____	____	____
Age	-0.046	-0.042	-0.021	0.017	-0.206**	-1.475***
	(0.032)	(0.035)	(0.041)	(0.043)	(0.083)	(0.522)
Age^2	0.0006*	0.0006	0.0003	-0.00004	0.00241**	0.018***
	(0.0003)	(0.0004)	(0.0004)	(0.0004)	(0.0009)	(0.0066)
Literacy Score	-0.116*	-0.104	-0.068	-0.095	-0.0532	7.179****
	(0.064)	(0.066)	(0.091)	(0.098)	(0.116)	(2.038)
Highest Grade of Education	0.005	0.008	0.014	0.028	-0.039	-0.770***
	(0.015)	(0.016)	(0.019)	(0.022)	(0.030)	(0.293)
Control for Plots being Managed by the Same Manager	-0.003****	-0.002****	-0.002****	-0.001****	-0.002**	-0.023***
	(0.0005)	(0.0005)	(0.0007)	(0.0003)	(0.0006)	(0.0076)
Number of Plots Managed by Same Manager	-0.009	-0.004	-0.040	0.047	0.313*	11.87**
	(0.067)	(0.072)	(0.081)	(0.076)	(0.189)	(5.171)
Number of Plots Managed by Same $Manager^2$	0.002	0.003	0.005	-0.003	-0.039**	-1.165**
	(0.005)	(0.006)	(0.006)	(0.006)	(0.020)	(0.555)
Tenancy Status	-0.392**	-0.381**	-0.539***	-0.566**	-0.188	-2.374*
	(0.167)	(0.182)	(0.202)	(0.227)	(0.358)	(1.235)
Disease and pest control	-0.043	-0.040	0.062	0.028	-0.276	5.741***
	(0.134)	(0.144)	(0.177)	(0.194)	(0.230)	(1.902)
Organic residue management	-0.102	-0.139	-0.222	-0.301	-0.068	6.66
	(0.159)	(0.169)	(0.202)	(0.221)	(0.289)	(4.628)
Irrigation	0.294*	0.358*	0.430*	0.662**	0.342	-11.40*
	(0.170)	(0.185)	(0.242)	(0.307)	(0.301)	(5.898)

Table A.24 Cont.: Sources of Technical Inefficiency from Models with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Other Extension Services Received	0.120	0.198	0.196	0.485	-0.308	4.06
	(0.320)	(0.363)	(0.422)	(0.552)	(0.540)	(2.508)
Village	0**	0**	0			
	(0.000)	(0.000)	(0.000)			
Total Productive Activities that the Manager Participates in		-0.045		-0.152		5.366****
		(0.066)		(0.094)		(1.384)
Level of Input in Productive Activities		-0.092		-0.108		-2.153*
		(0.091)		(0.116)		(1.163)
Level of Input on Income Use		-0.085		-0.077		-8.031**
		(0.075)		(0.092)		(3.425)
Percent of Assets Self-Owned		0.609**		0.342		9.296**
		(0.250)		(0.445)		(3.896)
Access to Credit		0.048		-0.034		4.994***
		(0.082)		(0.101)		(1.634)
Control over Credit		-0.035		0.021		-4.009****
		(0.088)		(0.122)		(1.217)
Total Groups the Manager is Highly Active in		0.021		0.026		2.649****
		(0.048)		(0.063)		(0.609)
Prevalence of Manager Having Input into All Group Decisions		-0.124*		-0.215**		-5.577**
		(0.075)		(0.100)		(2.739)
they fear they will get in trouble		0.109		0.182		1.706
		(0.119)		(0.151)		(1.560)
how others will view their actions		0.098		0.284**		-0.183
		(0.093)		(0.125)		(1.038)
they feel it is the right thing to do		0.327		0.371		4.548*
		(0.214)		(0.263)		(2.367)

Table A.24 Cont.: Sources of Technical Inefficiency from Models with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
Percent of Household Decisions that the Manager has High Extent of Influence		0.025		-0.043		2.462**
		(0.056)		(0.069)		(1.160)
Hours Spent Farming or Fishing		0.002		-0.026**		1.283***
		(0.009)		(0.012)		(0.448)
Hours Spent on Personal Care		0.126*		0.091		0.79
		(0.065)		(0.078)		(0.671)
Hours Spent Cooking		-0.027		-0.039		0.247
		(0.045)		(0.108)		(0.288)
Hours Spent caring for Children or the Elderly		0.021		0.009		1.887***
		(0.018)		(0.035)		(0.585)
Hours Spent Sleeping or Resting		0.001		-0.024		1.519***
		(0.012)		(0.015)		(0.570)
1st Quartile - Land Size (ha)	0.068	0.096				
	(0.324)	(0.342)				
2nd Quartile - Land Size (ha)	0.174	0.186				
	(0.253)	(0.269)				
3rd Quartile - Land Size (ha)	0.111	0.125				
	(0.207)	(0.225)				
4th Quartile - Land Size (ha)	----	----				
	----	----				
1st Quartile - Improved Seed (kg)	0.118	0.0771	0.331	0.170	-0.235	-5.247***
	(0.334)	(0.344)	(0.377)	(0.424)	(0.654)	(1.622)
2nd Quartile - Improved Seed (kg)	-0.109	-0.170	-0.174	-0.345	0.362	-2.243**
	(0.276)	(0.287)	(0.313)	(0.350)	(0.537)	(1.124)
3rd Quartile - Improved Seed (kg)	-0.006	-0.055	0.028	-0.045	0.00797	-2.493***
	(0.214)	(0.223)	(0.259)	(0.291)	(0.423)	(0.943)
4th Quartile - Improved Seed (kg)	----	----	----	----	----	----
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Table A.24 Cont.: Sources of Technical Inefficiency from Models with Quartile Variables

Variable	Full Sample		Male Managed		Female Managed	
	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics	Without Empowerment Metrics	With Empowerment Metrics
	(1)	(2)	(3)	(4)	(3)	(4)
1st Quartile - Basal Fertilizer (kg)	0.371*	0.430**	0.212	0.306	0.883	29.190****
	(0.190)	(0.199)	(0.218)	(0.240)	(0.568)	(8.686)
3rd Quartile - Basal Fertilizer (kg)	0.063	0.009	-0.066	-0.065	0.207	28.040***
	(0.194)	(0.198)	(0.232)	(0.244)	(0.405)	(8.837)
4th Quartile - Basal Fertilizer (kg)	----	----	----	----	----	
	----	----	----	----	----	----
1st Quartile - Top-Dressing Fertilizer (kg)	0.637**	0.587**	0.921**	0.927**	-0.248	-0.382
	(0.280)	(0.293)	(0.392)	(0.467)	(0.490)	(1.160)
2nd Quartile - Top-Dressing Fertilizer (kg)	0.599**	0.638**	0.635	0.674	0.665	6.127***
	(0.305)	(0.321)	(0.421)	(0.484)	(0.774)	(1.948)
3rd Quartile - Top-Dressing Fertilizer (kg)	0.520**	0.547**	0.553*	0.686*	0.452	5.887****
	(0.227)	(0.240)	(0.326)	(0.384)	(0.547)	(1.769)
4th Quartile - Top-Dressing Fertilizer (kg)	----	----	----	----	----	----
	----	----	----	----	----	----
1st Quartile - Pesticide (kg)	-0.0996	-0.0662	-0.260	-0.221	0.129	-1.050
	(0.248)	(0.250)	(0.389)	(0.437)	(0.405)	(1.038)
2nd Quartile - Pesticide (kg)	-0.452	-0.216	-0.950**	-0.672		
	(0.328)	(0.351)	(0.467)	(0.522)		
3rd Quartile - Pesticide (kg)	0.163	0.253	-0.0127	0.102	-0.226	-1.114
	(0.222)	(0.230)	(0.332)	(0.358)	(0.555)	(0.933)
4th Quartile - Pesticide (kg)	----	----	----	----	----	----
	----	----	----	----	----	----
Constant	0.656	-1.006	0.0848	-1.967	3.438*	-97.96***
	(1.003)	(1.531)	(1.286)	(2.081)	(1.914)	(34.260)

Notes: Negative sign indicates the variable has a positive impact on technical efficiency. Fourth quartile dropped due to dummy variable trap. Quartile for land area dropped in gendered sub-samples due to multicollinearity. Based on the distribution of that input, there was no second quartile for basal fertilizer. No observations for second quartile of basal fertilizer. Estimates are rounded to the thousandths place when feasible, ten-thousandths place otherwise. Robust Huber-white standard errors are reported in parentheses. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.25: Pearson Correlation Coefficients between Empowerment Metrics and Inputs

Empowerment Metrics	Inputs					
	Land (ha)	Improved Seed (kg)	Basal Fertilizer (kg)	Top-Dressing Fertilizer (kg)	Pesticide (kg)	Hired Laborers
Total Productive Activities that the Manager Participates in	0.0161	-0.0347	-0.0019	0.0109	0.0231	0.0308
Level of Input in Productive Activities	-0.0195	-0.0429	-0.0387	-0.0353	-0.0428	0.0864***
Level of Input on Income Use	-0.0662**	-0.0672**	-0.0415	-0.0327	-0.0392	-0.0100
Percent of Assets Self-Owned	-0.0695**	-0.0482	-0.0604**	-0.0504*	-0.0260	-0.0906***
Access to Credit	-0.0211	0.0090	0.0514*	0.0206	0.0701**	-0.0289
Control over Credit	-0.0714**	-0.0511*	0	-0.0305	-0.0054	-0.0484*
Total Groups the Manager is Highly Active in	0.0329	-0.0379	-0.0029	0.0350	-0.0257	-0.0225
Prevalence of Manager Having Input into All Group Decisions	-0.0006	-0.0039	0.0108	-0.0090	0.0132	0.0183
Average of Frequency that the Manager makes decisions because						
they fear they will get in trouble	0.00316	-0.0271	0.0629**	-0.0102	-0.0236	0.0750**
how others will view their actions	0.0013	-0.0494*	0.0512*	-0.0321	-0.0147	0.0524*
they feel it is the right thing to do	0.0765***	0.0235	0.0056	0.0150	0.0219	0.1130****
Percent of Household Decisions that the Manager has High Extent of Influence	0.0035	0.0014	0.0047	-0.0407	-0.0378	0.0758***
Hours Spent Farming or Fishing	0.105****	0.0805***	0.1580****	0.0600**	0.0671**	0.2090****
Hours Spent on Personal Care	-0.0198	-0.0166	-0.0093	0.0225	-0.0296	-0.0588**
Hours Spent Cooking	-0.0758***	-0.0628**	-0.0337	-0.0425	-0.0309	-0.0556*
Hours Spent caring for Children or the Elderly	-0.0226	-0.0026	-0.0193	-0.0059	0.0071	-0.0399
Hours Spent Sleeping or Resting	0.0953***	0.0538*	0.0027	0.0605**	0.0492*	0.0479

Notes: Estimates are rounded to the ten-thousandths place. * p<0.10, ** p<0.05, *** p<0.01. ****p<.0001

Table A.26: Two-Tailed Means Tests for Application of Extension Service Practices

	Female Farmers (N)	Male Farmers (N)	Female Farmer Mean	Male Farmer Mean	p-value
Received Extension Service					
Row Planting	49	118	1.71	1.653	0.197
Irrigation	22	54	1.870	1.841	0.394
Organic residue management	38	97	1.775	1.715	0.146
Disease and pest control	58	136	1.657	1.600	0.215
Applied Extension Practice					
Row Planting	49	118	1.612	1.517	0.263
Irrigation	22	54	1.591	1.537	0.673
Organic residue management	38	97	1.579	1.515	0.51
Disease and pest control	58	136	1.603	1.64	0.634

Notes: Application of practice is conditional on having received the extension service. Receipt and application of extension are binary variables where 1 indicates "Yes" (practice was received and/or applied) and 2 indicated "No" (practice was not received and/or applied).