Food and Agriculture Organization of the United Nations

Gender gap in agricultural labour productivity: A cross-country comparison

Background paper for

The status of women in agrifood systems

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Food and Agriculture Organization of the United Nations
Rome, 2024

Required citation:
Piedrahita, N., Costa, V. and Mane, E. 2024. *Gender gap in agricultural labour productivity: A cross-country comparison – Background paper for The status of women in agrifood systems*. Rome, FAO. https://doi.org/10.4060/cc9118en

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Abstract

Women in sub-Saharan Africa constitute almost half of the agricultural workforce, yet they are limited in their ability to access productive resources, such as land, water, improved seeds and fertilizers, and are subjected to discriminatory practices that hinder their productivity. While previous research has consistently identified a significant gender gap in land productivity, the literature lacks a comprehensive understanding of the gender gap in agricultural labour productivity. To bridge this research gap, we use data from the World Bank's Living Standards Measurement Study–Integrated Surveys on Agriculture in Ethiopia, Malawi, Nigeria, Uganda and the United Republic of Tanzania to examine whether there is a gender gap in the labour productivity of plot managers. We employed the Kitagawa–Oaxaca–Blinder decomposition to identify the main factors contributing to the productivity gap in these countries. Our findings reveal varying gender gaps across the sampled countries, ranging from 47 percent in Nigeria and the United Republic of Tanzania to 2 percent in Ethiopia, which is the only country with no significant gender gap in labour productivity. On average, the gender gap amounts to 35 percent, with the largest portion (27 percent) attributed to the endowment effect. Some of the primary drivers of the endowment effect include manager characteristics, labour and non-labour inputs, and the number of men in the household. Structural inequalities, linked to discrimination, accounted for a smaller portion of the gap (7 percent).

Acknowledgements

This background paper was prepared to inform Chapter 2 of FAO's report on *The status of women in agrifood systems*. The report provides a comprehensive view of the current status of women in agrifood systems globally and its evolution over the last decade The report was released on 13 April 2023 and is available at https://www.fao.org/documents/card/en/c/CC5060EN .

We are grateful for comments and advice received from Amparo Palacios-Lopez, Talip Kilic, Gustavo Anriquez and Vanya Slavchevska. We also acknowledge the valuable contribution made by Lauren Phillips and Benjamin Davis and all the participants to the expert consultations for the preparation of the FAO report on *The Status of women in agrifood systems*. The views expressed in this document are those of the authors and do not necessarily reflect the views or policies of FAO.

1 Introduction

Sub-Saharan Africa (SSA) is home to 1.17 billion people, representing 14.6 percent of the world's population (United Nations, 2022) and nearly 60 percent of the world's poor (Schoch *et al.*, 2022). The region has achieved significant socioeconomic advancements since the beginning of the twenty-first century, particularly in terms of agricultural production value, health and education (Jayne and Sanchez, 2021), resulting in the region having some of the highest average growth rates of gross domestic product (GDP) over the last decade (World Bank, 2022a). Nevertheless, SSA continues to grapple with significant challenges stemming from rapid population growth, slow poverty reduction and gender inequality. Projections indicate that by 2050 over 50 percent of the world's population growth will take place in SSA, with the population reaching an estimated 2.1 billion people (United Nations, 2022). Moreover, the region continues to heavily rely on agricultural production, which accounts for 17.2 percent of the region's GDP, compared with 4.3 percent worldwide (World Bank, 2022b). Additionally, women rely on agriculture more in SSA than in the rest of the world. Costa *et al*. (2023) found that women in SSA represent 50 percent of all agricultural workers, compared with 38 percent globally.

Women in agricultural occupations often face unfavourable conditions, such as limited access to infrastructure and markets, along with lower-quality job opportunities such as informal or part-time work. In Africa, 92 percent of women employed in agriculture work in vulnerable self-employment activities, 57 percent as own-account workers and 35 percent as contributing family workers (Costa *et al.*, 2023). Additionally, they encounter obstacles such as scarce alternative livelihood options, restricted access to resources and discriminatory social norms. Consequently, these factors contribute to a gender gap in land and labour productivity, as found by several researchers (e.g. Anderson *et al.*, 2021; Obisesan and Awolala, 2021; Singbo *et al.*, 2021; Danso-Abbeam, Baiyegunhi and Ojo, 2020; Sell *et al.*, 2018; Rodgers and Akram-Lodhi, 2019; Kilic, Palacios-Lopez and Goldstein, 2015; Ali *et al.*, 2016; Larson *et al.*, 2015; Slavchevska, 2015).

Measuring labour productivity is crucial to understanding women's and men's work conditions and standards of living. However, to the best of our knowledge, much of the current literature concerning gender disparities in agricultural productivity in SSA is centred around land productivity and resource access, leaving a significant gap in understanding the gender gap and its drivers in agricultural labour productivity. This study contributes to filling this gap. Through a Kitagawa–Oaxaca–Blinder mean decomposition approach, we delve into the differences in agricultural labour productivity between male- and female-managed plots in Ethiopia, Malawi, Nigeria, Uganda and the United Republic of Tanzania.

Our findings indicate an average agricultural labour productivity gap of 35 percent in favour of male managers. This gap varies considerably across countries, with a negligible 2 percent difference in Ethiopia to a substantial 58 percent difference in southern Nigeria. The primary reason for this gender disparity is the endowment effect, which refers to differential access to resources. Key factors that contribute to this gap include the utilization of both labour and non-labour inputs (such as fertilizer, improved seeds and agricultural implements), managerial attributes (such as age and marital status) and household characteristics (including wealth, off-farm income and proximity to essential infrastructure such as schools and markets).

The study is structured as follows. Section 2 presents a review of the evidence on the gender productivity gap. Section 3 presents the Kitagawa–Oaxaca–Blinder methodology. Sections 4 and 5 present the data, summary statistics and results. Section 6 offers concluding remarks and expands on the policy implications of our findings.

2 Gender differences in agricultural productivity: review of evidence

The gender gap in agricultural land productivity has been a focal point of numerous studies, which differ in their datasets, geographic and crop coverage and estimation strategies. At the heart of the gender gap are the prevailing social norms and discriminatory practices that limit women's access to resources. Numerous studies have highlighted the influence of factors such as limited access to land, improved seeds, male family labour and credit on the gender productivity gap (e.g. Anderson *et al.*, 2021; Obisesan and Awolala, 2021; van der Meulen Rodgers, 2018; de la O Campos, Covarrubias and Patron, 2016; Palacios-López and López, 2015). A review by Anderson *et al.* (2021) of 23 studies reveals lower land productivity among female-managed plots, a gap that is smaller in several studies that control for access to inputs. Similarly, Rodgers and Akram-Lodhi (2019) find that women's lack of access to cash translates to reduced adoption of new technologies by women, further reducing their land productivity. In a separate study focusing on six SSA countries, O'Sullivan *et al.* (2014) find that the gender gap in land productivity is partially driven by female managers' lower access to labour and non-labour inputs compared with their male counterparts.

It is not just lack of access to resources that can limit women's productivity. Societal norms further compound the challenges women face, often undermining their decision-making autonomy and limiting their mobility. Women, often restricted by greater domestic responsibilities, also encounter time limitations. These limitations may translate into lower productivity among female farmers (Doss, 2018; Namubiru-Mwaura, 2014; Ragasa *et al.*, 2013). Sell *et al.* (2018) emphasize the critical burden of time constraints on women's land productivity, particularly among maize farmers in Uganda.

O'Sullivan *et al.* (2014) find that, while countries across SSA have made important advances in achieving gender parity in education, the inequities of previous decades continue to hinder women's land productivity today in Malawi and Uganda. Encouragingly, Mobarok, Skevas and Thompson (2021) show that empowering women to make independent choices regarding agricultural production is positively associated with land productivity and efficiency growth among Bangladeshi rice farmers.

However, while factors affecting the gender gap in land productivity are well-studied, there remains a gap in the study of the gender gap in labour productivity in the agricultural sector. The existing literature on gender gaps in agricultural productivity predominantly focuses on land productivity and access to resources, leaving a significant research gap in understanding of the gender gap and its drivers in agricultural labour productivity. Measuring labour productivity is essential for meaningful cross-industry comparisons, as it is the more common measure of partial factor productivity. This would also allow comparison of productivity across sectors of the agrifood systems beyond agriculture, such as forestry, fisheries, food processing, trade, transportation and food services. Labour productivity often serves as a proxy for living standards: Krugman (1994) posits that a country's ability to improve its standard of living hinges largely on its capacity to enhance output per worker. The average product of labour is an indicator of how much value a worker produces.

Examining the gender gap in agricultural labour productivity presents two key challenges. First, as outlined by Doss (2018), many studies that examine labour productivity often focus on days of work, but this assumes that every

day's work is identical in terms of hours and effort. Women often have greater household burdens regarding child care and other household chores, leaving less time for agricultural work (Doss, 2018). Moreover, the time and effort spent on household chores may change daily based on the family needs. If only days of labour are considered, and women work fewer hours than men, the gender gap will likely be overestimated. Ideally, we would have access to data that tracks the amount of effort throughout the day. However, in the absence of such data, recent household surveys have incorporated more in-depth questions regarding time spent on work, such as hours of work, to better capture women's engagement in agricultural labour (e.g. McCollough, 2017; Palacios-Lopez and Lopez, 2015). In this paper, we compare the gender gap using both days and hours of labour when both sets of data are available.

The second challenge when measuring the gender gap in labour productivity is the selection of the gender variable. In farm-level studies, gender is often defined based on the sex of the household head (e.g. Songsermsawas, Kafle and Winters, 2023; Gebre *et al.*, 2019; Obisesan and Awolala, 2021; Rodgers and Akram-Lodhi, 2019). However, this definition is not always accurate given that different members of the household may manage different plots. Moreover, it is worth noting that the number of women who are household heads is relatively low. To address this issue, studies have been moving towards considering the sex of farm and plot managers. De la O Campos, Covarrubias and Patron (2016) examine the implication of using different gender indicators to measure the gender gap in land productivity. More specifically, they compare whether defining gender by the sex of the head of household, principal plot holder and plot manager affects the estimates of gender productivity gap among farmers in Uganda. The results suggest that the choice of gender indicator matters for two reasons: 1) it helps identify the role of decision-making that potentially influences land productivity; and 2) the roles of men and women overlap, with tasks being shared in the same plot.

To address these challenges, this study incorporates data on hours of work when available and uses the sex of the manager of each plot.

3 Methods

We use the decomposition approach developed by Kitagawa (1955), Oaxaca (1973) and Blinder (1973) to examine gender gap in agricultural labour productivity. The Kitagawa–Oaxaca–Blinder decomposition has been widely used in the labour economics literature to measure gender wage gaps (Bediakon *et al.*, 2022; Mysíková, 2012; Johansson, Katz and Nyman, 2005; Tenjo, Rocío and Fernanda, 2002; Paz, 1998). More recently, it was used by Kilic, Palacios-Lopez and Goldstein (2015) to examine the gender gap in land productivity between plots managed by men and those managed by women. Palacios-López and López (2015) expanded the model to decompose agricultural labour productivity between plots belonging to male- and female-headed households to examine the effect of market failures on the gender gap. Recent studies have applied the Kitagawa–Oaxaca–Blinder decomposition to understand gender gaps in firm labour productivity in Viet Nam and SSA countries (Hoang, Nahm and Dobbie, 2021; Islam *et al.*, 2018; Bernardini Papalia and Pinuccia, 2008).

We apply the methods developed by Palacios-López and López (2015) and Kilic, Palacios-Lopez and Goldstein (2015) to examine the gender gaps in agricultural labour productivity between plots managed men and those managed by women. Results are decomposed into: 1) the portion driven by observable differences in the factors of production (called the *endowment effect*), which encompasses variables such as characteristics of the household, manager, gender, land, plot and inputs and 2) the unexplained portion driven by differences in returns to the same observed factors of production (called the *structural effect*), which encompasses social norms or any other factor that cannot be captured as part of the endowment effect. It should be noted that while these decomposition methods are useful for identifying the contribution of various factors to the difference in the endowment and structural effects, the contribution of each factor is based on correlations and cannot be interpreted as having a causal effect (Fortin, Lemieux and Firpo, 2011). Nevertheless, the approach does document the relative quantitative importance of factors in explaining an observed gap, thus suggesting priorities for further analysis and, ultimately, policy interventions (Kilic, Palacios-Lopez and Goldstein, 2015; Fortin, Lemieux and Firpo, 2011).

We begin by assuming the log of labour productivity (y), namely the gross value of output per hour of managerial labour for male (M) and female (F) plot managers can be estimated as:

(1) $$Y_G = \beta_{G0} + \sum_{k=1}^{K} X_{Gk}\beta_{Gk} + \epsilon_G$$

where $G \in \{M, F\}$; X is a vector of k observable explanatory variables at the individual and/or household level; β reflects the vector of slope coefficients and of the intercept; and ϵ reflects the error term, such that $E[\epsilon_G] = 0$.

Let "*D*" be the gender gap, which can be written as:

(2) $$D = E(Y_M) - E(Y_F)$$

where:

(3) $$E(Y_M) = \beta_{M0} + \sum_{k=1}^{K} E(X_{Mk})\beta_{Mk}$$

(4) $$E(Y_F) = \beta_{F0} + \sum_{k=1}^{K} E(X_{Fk})\beta_{Fk}$$

By subtracting equation 4 from equation 3, *D* can be rewritten as:

(5) $$D = E(Y_M) - E(Y_F) = \beta_{M0} + \sum_{k=1}^{K} E(X_{Mk})\beta_{Mk} - \beta_{F0} - \sum_{k=1}^{K} E(X_{Fk})\beta_{Fk}$$

The next step is to set β^* as the coefficient of a pooled regression with a dummy variable to identify male and female plot managers. According to Kilic, Palacios-Lopez and Goldstein (2015), "the inclusion of the group membership indicator in the pooled regression for the estimation of β^* takes into account the possibility that the mean difference in plot-level productivity measure is explained by gender of the plot manager." Then, we add and subtract β_0^* and the return of the observable covariates evaluated at β^*:

(6) $$D = \sum_{k=1}^{K} \underbrace{[E(X_{Mk}) - E(X_{Fk})]\beta_k^* + (\beta_{0M} - \beta_0^*)}_{Endowment\ effect} + \underbrace{\sum_{k=1}^{K} \underbrace{[E(X_{Mk})(\beta_{Mk} - \beta_k^*)}_{male\ structural\ advantage} + \underbrace{\sum_{k=1}^{K}[E(X_{Fk})(\beta_{Fk} - \beta_k^*)}_{Female\ Structural\ advantage}}_{Structural\ Advantage}$$

The endowment effect is the portion of the gap explained by differences in the levels of observable covariates between men and women, while the structural effect refers to the portion of the gender gap driven by deviations of each group return from the average/pooled return. In practice, we begin by estimating equation 1 for male-managed plots, female-managed plots and for the pooled sample, which includes a dummy variable to identify the male- and female-managed plots (Kilic, Palacios-Lopez and Goldstein, 2015).

4 Data and summary statistics

To examine labour productivity gender gaps, we generated labour productivity measures and other key variables from the Living Standards Measurement Survey–Integrated Surveys in Agriculture (LSMS–ISA) dataset (World Bank, 2023) and from FAO's Rural Livelihoods Information System (RuLIS) (FAO, 2023). We drew on a cross-section of recent LSMS–ISA datasets available, comprising the Ethiopia Rural Socioeconomic Survey (2018–2019), the Malawi Integrated Household Survey (2019–2020), the United Republic of Tanzania National Panel Survey (2014–2015) and the Uganda National Panel Survey (2015–2016).[1] We also incorporated data on agricultural incomes and socioeconomic characteristics from RuLIS. Details of the variables considered in the analysis are shown in Table A1 in Appendix A.

The sample was restricted to men and women who are the primary decision-makers for at least one plot for which a crop harvest was reported during the survey year. The gender of the plot manager was defined based on whether the primary decision-maker was male or female. Table 1 shows the sample size in each country together with the proportion of male and female plot managers. On average, 28 percent of plot managers were women and 72 percent were men, with the share of female plot managers ranging from 8 percent in northern Nigeria to 42 percent in Uganda.[2] Our findings suggest that female plot managers have lower agricultural labour productivity than male plot managers in all the countries examined. However, the gender gap[3] is consistently smaller when measuring agricultural labour productivity in terms of hours as opposed to days (Figure 1), with the differences ranging from 2 percentage points in Malawi to 25 percentage points in Ethiopia. This is in line with the findings of Doss (2018).

Table 1. Sample size and percentage of female and male plot managers

	Northern Nigeria	Southern Nigeria	United Republic of Tanzania	Ethiopia	Malawi	Uganda
Sample size	4 017	1 979	3 080	1 550	12 679	6 086
Female plot managers (%)	8	35.8	28	17.35	40.7	41.8
Male plot managers (%)	91.81	64	72	82.7	59.3	58.2

Note: The analysis in Nigeria was disaggregated in two geographical subregions based on the hypothesis that northern and southern Nigeria present substantial cultural and socioeconomic differences. See Appendix C for a more detailed explanation.
Source: Authors' calculations.

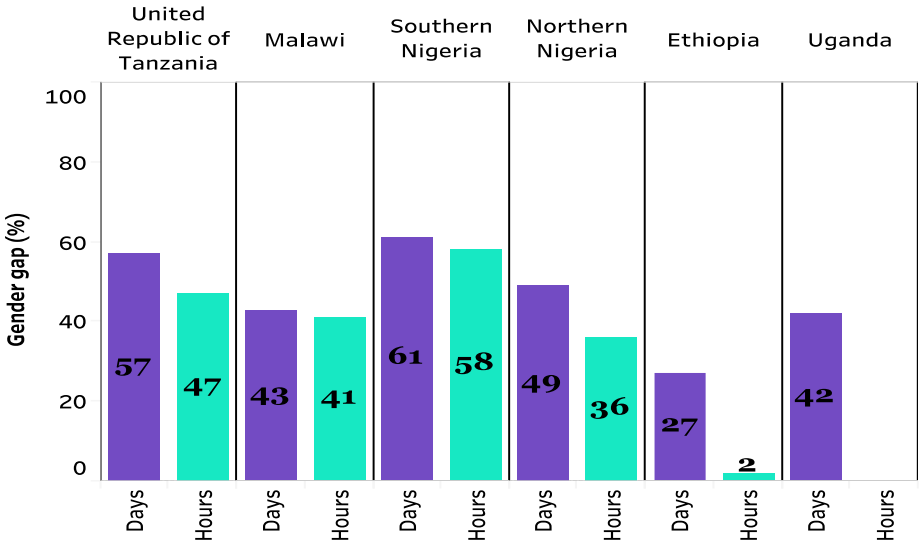
Descriptive statistics with significance tests of mean differences are shown by country in Table A2 in Appendix A. Output per hour of labour was significantly higher for male-managed plots than for female-managed plots in all

[1] In the LSMS–ISA surveys, the household module provides a wide range of information on households' living conditions, including demographics, household composition, education, income and assets. Additionally, the agricultural module, which is typically administered to households that report involvement in farming, crop cultivation, livestock rearing or other agricultural practices, is designed to gather detailed information on various aspects of agricultural production, including landholdings, crop choices, livestock ownership, input use, labour allocation and income generated from agricultural activities.
[2] For an explanation of why the analysis for Nigeria is done separately for the northern and southern regions, see Appendix C.
[3] The gender gap is measured using the Kitagawa–Oaxaba–Blinder decomposition approach explained in section 3.

regions except for Ethiopia, where the difference was not statistically significant., the gender productivity differences are also evident in the comparison of the kernel densities (Figure B1, Appendix B).

Across the countries examined, male-managed plots were significantly larger than female-managed plots. Moreover, in several countries, female-managed plots were less likely to utilize fertilizers or improved seeds, indicating potential differences in access to agricultural inputs. The agricultural implements index, which measures the availability and utilization of farming tools,[4] also tended to be lower for female-managed plots. Regarding labour inputs, male-managed plots had a greater incidence of hired labour, while female-managed plots used a greater amount of household labour on average. The higher incidence of household labour might be a way to compensate for having less access to outside labour or fewer resources to hire such labour. Unsurprisingly, female plot managers tended to live in households with fewer men and a higher child-dependency ratio. Female plot managers were also older and more likely to be single or widowed but less likely to be married.

Figure 1. Gender gap in labour productivity when measured in days versus hours[5]



Note. Uganda does not collect hours worked.
Source: Authors' calculations.

[4] The ownership of agricultural tools is measured as the agricultural implements index that reflects tool ownership (e.g. hoes, axes, etc. depending on the survey) and is estimated using principal component analysis.
[5] The Uganda survey provides no information on hours of work, thus we report the managerial gender labour productivity gap based only on the number of days worked by the farm manager.

5 Results and discussion

To examine the gender gap in agricultural labour productivity, we first need to estimate equation (1) by regressing productivity on relevant variables. This analysis is conducted separately for the pooled sample, male-managed plots and female-managed plots. These results are presented in Table A3 (Appendix A) in columns 1, 2 and 3, respectively. Based on the findings, the average conditional gender gap after controlling for observable factors amounts to 16 percent. These figures indicate that men exhibit higher labour productivity levels than women except in northern Nigeria and Ethiopia, where women appear to be more productive than men, although these differences are not statistically significant in Ethiopia.

The subsequent step in the analysis involves conducting the Kitagawa–Oaxaca–Blinder decomposition by estimating equation 6 for countries or regions where a significant productivity gap exists, namely Malawi, northern and southern Nigeria, Uganda and the United Republic of Tanzania.[6] Table 2 shows the average gender gap for all five countries along with the average value of the contributing factors. Overall, we found an average gap of 35 percent, with the endowment effect being the leading driver. The endowment effect, which accounts for differences in observable attributes, was the main contributor to the gender gap in productivity in Malawi, northern and southern Nigeria and the United Republic of Tanzania (Figure 2), whereas the structural effect was the primary driver of the gender gap in Uganda. However, the structural effect also plays an important role in southern Nigeria, Malawi and the United Republic of Tanzania, suggesting that discriminatory norms remain important drivers of the gender gap.

Table 3 displays the contribution of various factors to the endowment effect, while more detailed decomposition results can be found in Table A4 in Appendix A. Manager characteristics, such as sex, age and civil status, were important contributors to the endowment effect in all countries, particularly in Uganda, where they explain 77 percent of the gender gap. However, they did not have statistically significant effect in northern Nigeria. Household characteristics, such as the number of men in the household, were on average higher in households with male-managed plots, contributing to an increased gender gap ranging from 17 percent of the endowment effect in Malawi to 50 percent in Uganda. Other household characteristics, such as whether the household had off-farm income and off-farm wage income, were less important for the endowment effect, contributing to a smaller gender gap in northern Nigeria. In addition, gender characteristics, such as the child-dependency ratio and the female labour share, were positively related to the endowment effect, particularly in the United Republic of Tanzania where they explained 24 percent of the gender gap.

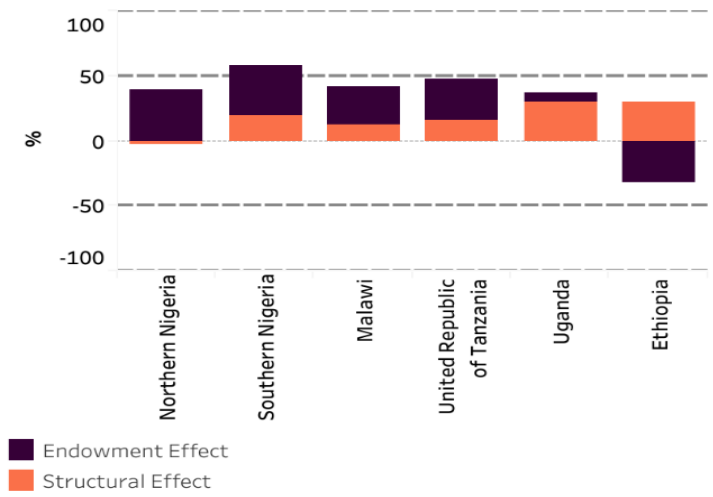
Table 2. Average labour productivity gaps (male versus female managers) and contributing factors

	Average gap (%)
Average gender gap	35
Average endowment effect	28
Average structural effect	7

Note: Labour productivity gend er gap in Ethiopia is not statistically significant. *Source*: Authors' calculations.

[6] The gender gap in labour productivity in Ethiopia is not statistically significant.

Figure 2. Endowment versus structural effects



Note: Labour productivity gender gap in Ethiopia is not statistically significant.
Source: Authors' calculations

Context for the abovementioned findings can be found in the summary statistics and regression results in Tables A2 and A3 in Appendix A. For instance, regarding the managers' characteristics, productivity tends to be higher among married plot managers, but female plot managers are less likely to be married than are male plot managers. In terms of gender characteristics, a higher child-dependency ratio tended to have a more adverse effect on women's productivity than on men's in all countries, except for Nigeria (see columns 2 and 3 of Table A3 in Appendix A). Women often shoulder a greater portion of care-giving responsibilities and household chores than do men. These duties can take time and energy away from agricultural work. Men on the other hand, often face fewer restrictions in allocating their time and resources to work, enabling them to have higher productivity levels.

Findings are consistent with the land productivity literature, where several papers such as Sell *et al.* (2018), Ali *et al.* (2016) and O'Sullivan *et al.* (2014) find that manager and household characteristics may reduce women's productivity, particularly the burden of child care and household chores. O'Sullivan *et al.* (2014), in a study of six African countries, also found that female managers live in smaller households with fewer men, which lowered their access to household male family labour.

Table 3. Contribution of different factors to the endowment effect (%)

	Northern Nigeria	Southern Nigeria	Malawi	United Republic of Tanzania	Uganda
Manager characteristics	19	**31**	**17**	**28**	**77**
Hired labour	0	2	4	6	4
Family labour	59	40	9	12	18
Non-labour inputs	39	21	31	11	6
Number of men in HH	33	21	17	22	50
Number of women in HH	4	1	−2	4	−15
Gender characteristics	4	**8**	**13**	**24**	−4
Plot size	−15	−18	−5	−6	−3
Other household characteristics	−12	5	2	2	−2

Note: This table is created following **Rodgers, Y. & Akram-Lodhi, H.** 2019. *The gender gap in agricultural productivity in sub-Saharan Africa: causes, costs and solutions*. Policy Brief No. 11. New York, USA, UN Women, with the main contributing factors to the endowment effect. Percentages do not sum to 100 as the decompositions includes other categories, some with negative values. Statistically significant results are in bold.

Another factor contributing to an increase in the gender gap is the reliance on family and hired labour. Plots managed by women were on average more dependent on family labour than those managed by men (Table A2 in Appendix A), which tends to be negatively associated with managerial labour productivity in all countries (Table A3 in Appendix A). The only exception is northern and southern Nigeria, where the reliance on family labour is higher in male than in female-managed plots (Table A2 in Appendix A). Family labour refers to people who help another family member run an agricultural holding but are not considered employees (Eurostat, 2023). Increased burden of unpaid domestic work and care-giving responsibilities may constrain female managers' ability to manage their plots as efficiently as possible. The higher reliance on family labour among female managers may also be indicative of limited access to external support and resources. For instance, households with female plot managers are less likely to have off-farm wage income and thus may have less access to cash to hire labour, which can contribute to closing the gender productivity gap. The results suggest that an increase in the utilization of hired labour can have a greater impact on women's agricultural productivity than on men's productivity.

Non-labour inputs, such as seeds and fertilizers, also may contribute to increasing the gender gap in all countries. In Uganda and Malawi, women are less likely to use improved seeds than men and when they do use them it is at a lower intensity (see log results in Table A2). These findings are in line with the literature, which has found that women have lower resource endowments (e.g. Anderson *et al.*, 2021; Singbo *et al.*, 2021; Danso-Abbeam, Baiyegunhi and Ojo, 2020) and a lower intensity of adoption of new technologies (e.g. Mobarok, Skevas and Thompson, 2021; Singbo *et al.*, 2021; Gebre *et al.* 2019). The pooled regressions in Table A3 in Appendix A show that, in most countries examined, ownership of agricultural tools may be correlated with the use of inorganic fertilizers, which will contribute to higher productivity. However, it is noteworthy that, in general, ownership of agricultural tools had a greater impact on women's agricultural labour productivity than on men's agricultural

labour productivity. Similarly, greater use of fertilizer per hectare enhances productivity for both men and women on average in most countries.

Moreover, we observed that land size tended to be negatively associated with agricultural labour productivity both in plots managed by women and in those managed by men (Table A3). Our findings indicate that either productivity decreases as land size increases or that there is a U-shaped relationship depending on the country. While the inverse relationship between land size and land productivity has been a common finding in the literature at the plot and farm level across locations and crop choices, the evidence regarding labour productivity and land size is mixed. For instance, Akpan (2020) and Obike, Idu and Aigbokie (2016) find that, in Nigeria, farm size is inversely associated with productivity among small-scale waterleaf and coca farmers, respectively. Conversely, Adamopoulos and Restuccia (2014) found that larger farms in the United States exhibit higher labour productivity. Smallholders may sometimes face productivity advantages, particularly at earlier stages of development. However, as markets grow and countries develop, these advantages tend to diminish, and farming operations shift towards economies of scale (Julien, Bravo-Ureta and Rada, 2019).

On the one hand, larger farms have greater access to capital and labour-saving technologies than do smaller farms, allowing them to produce more output per worker. On the other hand, there is also a potential moral hazard problem for the plot manager as the cost of managing hired labour is higher than that of managing family labour (Eswaran and Kotwal, 1986). As a result, there is an economic advantage in keeping small farms dependent on potentially less-productive forms of family labour. Risk-averse households may also oversupply family labour to their own farms and undersupply hired labour to the market in an effort to achieve self-sufficiency and reduce the risk of exposure to fluctuations in the price of food (Barrett, 1996). Foster and Rosenzweig (2022) developed a theoretical model that explains the U-shaped relationship between land size and productivity whereby the smallest and largest farms have the highest levels of productivity. The problem with medium-sized farms is that they are too large to rely solely on family labour but are too small to warrant the adoption of labour-saving technologies and the cost of managing hired labour.

Finally, we observed the proportion of the gap that results from unequal returns to the various factors (the structural effect), which encompasses social norms or any other factor that cannot be captured as part of the endowment effect. While the structural effect is statistically significant in southern Nigeria, Malawi, Uganda and the United Republic of Tanzania, in Uganda, the structural effect (30 percent) explains the largest portion of the gender gap (81 percent). In Uganda, the largest contributors to the structural effect are differential returns to household labour, number of men in the household, and manager characteristics. For the remaining countries, the structural effect explains around on average around 30 percent of the average gender gap in agricultural labour productivity, but there are no patterns surrounding the contribution of the various factors to the structural effect.

6 Conclusion and discussion

This study sheds light on mechanisms underlying the gender gap in agricultural labour productivity in five SSA countries. The gender gap was significant in all the countries except Ethiopia. Overall, we found an average gender gap of 35 percent favouring male plot managers. These findings are consistent with Palacios-López and López (2015), who found that in Malawi, labour productivity was, on average, 44 percent lower on plots managed by female-headed households than on those managed by male-headed households. The results show the relative importance of various factors behind the gender gap. For instance, while the endowment effect is the primary driver of the gender gap, differences in the use of labour and non-labour inputs explain most of the gender gap.

The structural effect, including discrimination, also explains a large proportion of the gender gap, particularly in Uganda, where the structural effect (30 percent) explains 81 percent of the gender gap. This is primarily explained by differential returns to manager characteristics and the number of men in the household.

This study sheds light on the magnitude and factors underlying the gender gap in labour productivity. Policies encouraging the adoption of higher-quality inputs, such as improved seeds, fertilizers and other labour-saving technologies, may help counteract the effect of limited access to male family labour and to hired labour. However, these types of policies alone cannot close gaps in labour productivity driven by the structural effect, including discriminatory social norms, which must be addressed through other methodologies that seek to engage with the root causes of inequality. This can include interventions focused on promoting gender-equitable attitudes and practices, engaging men and boys in discussions about gender equality, and empowering women through leadership roles and decision-making processes. Further research is needed to determine the exact mechanisms through which these transformative policies can help improve women's productivity and thus reduce the gender gap. In addition to examining disparities in effort, future research should also explore how increased access to education and child care, along with transformative efforts to reshape gender norms, can enhance women's labour productivity.

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Appendices

Appendix A: Tables

Table A1. List of variables

	Variable	Units
Manager characteristics	Manager's age	years
	Manager is married	dummy (0,1)
	Manager is widowed	dummy (0,1)
Inputs	ln (household family labour)	hours/ha
	ln (hired labour)	expenditure/ha
	ln (other inputs per ha)	expenditure/ha
	Agricultural Implements index	principal component scores
	ln (improved seeds per ha)	cost/ha
	Uses improved seeds	dummy (0,1)
	Uses organic fertilizer	dummy (0,1)
	Uses inorganic fertilizer	dummy (0,1)
	ln (inorganic fertilizer per ha)	cost/ha
	ln (organic fertilizer per ha)	cost/ha
Household characteristics	Number of men in household	#
	Number of women in household	#
	Has off-farm own income	dummy (0,1)
	Has off-farm wage income	dummy (0,1)
	Distance to primary school	time or length (kms)
	Distance to market	time or length (kms)
	Distance from plot to household	time or length (kms)
	Wealth index	principal component scores
	Manager received extension services	dummy (0,1)
	Other assistance	dummy (0,1)
Land	Plot size	ha
Plot characteristics	Irrigation	dummy (0,1)
	Number of Parcels managed	#
	Plot is rented	dummy (0,1)
Gender characteristics	Child-dependency ratio	dummy (0,1)
	Female Labour Share	dummy (0,1)
Crops	Plants legumes	dummy (0,1)
	Plants cash crops	dummy (0,1)
	Plants other crops	dummy (0,1)
	Staples	dummy (0,1)
	Intercropped	dummy (0,1)

Table A2. Summary statistics, mean of differences (unweighted)

	Northern Nigeria			Southern Nigeria			Malawi		
	Men	Women	Difference	Men	Women	Difference	Men	Women	Difference
Labour productivity per hour	6.383	6.021	0.361***	5.369	4.786	0.582***	6.14	5.727	0.412***
Manager characteristics									
Manager's age	46.276	50.623	−4.347***	51.622	54.525	−2.902***	43.443	45.473	−2.029***
Married manager	0.956	0.295	0.66***	0.921	0.275	0.646***	0.937	0.404	0.532***
Widowed manager	0.007	0.59	−0.582***	0.031	0.629	−0.598***	0.017	0.27	−0.252***
Inputs									
ln (household family labour)	−2.742	−2.48	−0.262***	−1.652	−1.438	−0.214***	−2.393	−2.349	−0.043***
ln (hired labour)	−0.32	−0.325	0.004	−0.302	−0.701	0.399**	−2.656	−3.058	0.401***
ln (other inputs per ha)	−3.722	−3.777	0.055	−2.441	−2.511	0.069	2.254	2.358	−0.103***
Agricultural Implements index	0.226	−0.174	0.399***	0.168	−0.254	0.421***	1.044	−0.082	1.125***
ln (improved seeds per ha)	−2.746	−2.906	0.159	−1.596	−1.771	0.174	−1.111	−1.665	0.554***
Uses improved seeds	0.112	0.091	0.02	0.161	0.179	−0.018	0.335	0.256	0.078***
Uses organic fertilizer	0.31	0.112	0.197***	0.097	0.102	−0.004	0.219	0.232	−0.012*
Uses inorganic fertilizer	0.502	0.307	0.194***	0.208	0.196	0.011	0.522	0.484	0.038***
ln (inorganic fertilizer per ha)	−0.475	−1.526	1.051***	−2.718	−2.935	0.216	−0.813	−1.822	1.009***
ln (organic fertilizer per ha)	−4.033	−4.25	0.216**	−4.036	−4.125	0.088	−1.15	−2.104	0.954***
Land									
ln (plot size)	−0.789	−1.26	0.47***	−2.102	−2.653	0.55***	−1.479	−1.726	0.246***
Household characteristics									
HH size men	3.746	2.41	1.336***	2.714	1.554	1.159***	2.524	1.831	0.692***
HH size women	3.616	2.781	0.834***	2.549	2.367	0.182**	2.386	2.531	−0.144***
Has off-farm own income	0.555	0.328	0.227***	0.572	0.43	0.141***	0.378	0.327	0.05***

	Northern Nigeria			Southern Nigeria			Malawi		
	Men	Women	Difference	Men	Women	Difference	Men	Women	Difference
Household characteristics									
Has off-farm wage income	0.127	0.119	0.008	0.156	0.162	−0.006	0.104	0.096	0.008
Distance to primary school	0.562	0.448	0.113	0.55	0.457	0.093	72.189	89	−16.811***
Distance to market							29.202	46.792	−17.59***
Distance from plot to household									
Wealth index	−0.678	−0.896	0.217**	0.245	−0.502	0.747***	−0.351	−0.63	0.278***
Received extension services	0.226	0.082	0.143***	0.143	0.106	0.036**	0.595	0.498	0.096***
Other assistance	0.165	0.061	0.104***	0.076	0.062	0.013	0.413	0.521	−0.107***
Plot characteristics									
Irrigation	0.026	0.009	0.016*	0.013	0.008	0.004	0.234	0.152	0.081***
Slope	0.044	0.043	0.001	0.053	0.075	−0.021**	0.104	0.113	−0.008
Plot is rented	0.1	0.091	0.009	0.223	0.203	0.019	0.083	0.049	0.034***
Gender characteristics									
Child-dependency ratio	0.001	0.09	−0.088***	0.003	0.084	−0.08***	0.003	0.234	−0.231***
Female labour share	0.303	0.584	−0.281***	0.424	0.694	−0.269***	0.388	0.618	−0.23***

Note: A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.001$.

Table A2. Continued

	United Republic of Tanzania			Uganda			Ethiopia		
	Men	Women	Difference	Men	Women	Difference	Men	Women	Difference
Labour productivity per hour	7.333	6.864	0.469***	4.491	4.119	0.371***	2.729	2.709	0.02
Manager characteristics									
Manager's age	44.173	48.824	−4.65***	44.329	46.505	−2.176***	45.25	46.911	−1.66*
Married Manager	0.809	0.274	0.534***	0.93	0.528	0.401***	0.902	0.45	0.452***
Widowed Manager	0.022	0.04	−0.018***	0.018	0.301	−0.282***	0.008	0.394	−0.386***
Inputs									
ln (household family labour)	−2.809	−2.74	−0.068**	−3.775	−3.749	−0.026*	−2.053	−1.712	−0.341***
ln (hired labour)	−1.1	−1.518	0.417***	−0.834	−0.917	0.083	−2.764	−2.439	−0.324
ln (other inputs per ha)	−3.113	−3.518	0.404***	−2.825	−2.966	0.141*	−4.334	−4.38	0.045
Agricultural Implements index	0.075	−0.119	0.193***	0.396	0.112	0.284***			
ln (improved seeds per ha)	−1.287	−1.73	0.442***	−0.597	−1.482	0.884***	−2.252	−2.424	0.172
Uses improved seeds	0.523	0.403	0.12***	0.327	0.147	0.179***	0.283	0.238	0.045
Uses organic fertilizer	0.131	0.13	0.001	0.075	0.084	−0.008			
Uses inorganic fertilizer	0.141	0.127	0.013	0.063	0.027	0.036***			
ln (inorganic fertilizer per ha)	−3.691	−3.799	0.108	−4.306	−4.468	0.162***			
ln (organic fertilizer per ha)	−4.518	−4.5	−0.017	−4.504	−4.524	0.019			
Land									
Plot size	−0.463	−0.917	0.453***	−0.527	−0.816	0.289***	−3.775	−4.618	0.842***
Household characteristics									
HH size men	3.088	2.067	1.021***	2.987	2.355	0.632***	2.863	1.684	1.178***
HH size women	2.987	2.79	0.196***	2.732	2.91	−0.177***	2.898	2.703	0.195*
Has off-farm own income	0.425	0.402	0.023	0.437	0.404	0.033***	0.181	0.234	−0.053**
Has off-farm wage income	0.227	0.191	0.036**	0.24	0.255	−0.015	0.155	0.167	−0.011
Distance to primary school				1.529	1.379	0.15***	0.915	0.751	0.163

	United Republic of Tanzania			Uganda			Ethiopia		
	Men	Women	Difference	Men	Women	Difference	Men	Women	Difference
Distance to market	9.743	8.37	1.373***						
Distance from plot to household	6.446	4.581	1.864	1.792	1.784	0.008			
Wealth index	−0.713	−0.967	0.254***	−0.113	−0.205	0.092***	−1.574	−1.43	−0.143***
Received extension services	0.167	0.109	0.057***	0.159	0.128	0.03***			
Other assistance	0.077	0.087	−0.009						
Plot characteristics									
Irrigation	0.04	0.029	0.011	0.015	0.024	−0.009***	0.499	0.416	0.082**
Slope	0.289	0.258	0.03*	0.064	0.076	−0.011*	0.095	0.03	0.065***
Plot is rented	0.12	0.08	0.04***	0.019	0.022	−0.003	0.037	0.022	0.014
Gender characteristics									
Child-dependency ratio	0.001	0.248	−0.246***	0.008	0.136	−0.128***	0.002	0.145	−0.142***
Female labour share	0.411	0.684	−0.273***	0.4	0.643	−0.242***	0.001	0.182	−0.181***

Note: A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.001$.

Table A3. Regression results (unweighted)

	Northern Nigeria			Southern Nigeria			Malawi		
	Pooled	Women	Men	Pooled	Women	Men	Pooled	Women	Men
Manager characteristics									
Sex	0.028			−0.196*			−0.126***		
	(0.098)			(0.107)			(0.023)		
Age	−0.001	0.033	−0.007	−0.011	−0.045**	0.008	0.003	0.005	0.002
	(0.008)	(0.035)	(0.008)	(−0.011)	(−0.022)	(−0.013)	(0.003)	(0.005)	(0.005)
Age squared	0.000	−0.000	0.000**	0.000	0.000**	0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Married manager	−0.097	−0.328	−0.065	0.040	−0.128	0.043	0.086***	0.031	0.205***
	(0.088)	(0.244)	(0.095)	(−0.137)	(−0.192)	(−0.212)	(0.028)	(0.034)	(0.057)
Widowed manager	−0.305**	−0.487*	−0.224	−0.154	−0.125	−0.188	0.004	−0.026	0.123
	(0.130)	(0.257)	(0.179)	(0.138)	(0.166)	(0.279)	(0.034)	(0.039)	(0.097)
Inputs									
ln (household family labour)	−0.876***	−0.779*	−0.889***	−0.719***	−0.693***	−0.751***	−0.571***	−0.599***	−0.552***
	(0.025)	(0.101)	(0.027)	(0.039)	(0.064)	(0.051)	(0.013)	(0.019)	(0.017)
ln (hired labour)	0.030***	0.043	0.027***	0.021**	0.018	0.027**	0.028***	0.029***	0.028***
	(0.006)	(0.027)	(0.006)	(0.010)	(0.016)	(0.014)	(0.003)	(0.005)	(0.004)
ln (other inputs per ha)	0.008	0.012	0.007	−0.000	−0.040*	0.026	0.042***	0.067***	0.029***
	(0.011)	(0.044)	(0.011)	(0.013)	(0.023)	(0.017)	(0.007)	(0.012)	(0.009)
Agricultural Implements index	0.135***	0.180**	0.132***	0.142***	0.188***	0.138***	0.052***	0.077***	0.045***
	(0.015)	(0.087)	(0.015)	(0.034)	(0.064)	(0.035)	(0.005)	(0.011)	(0.006)
ln (improved seeds per ha)	−0.026***	−0.088***	−0.022***	0.000	−0.039*	0.012	0.009**	0.000	0.015***
	(0.008)	(0.033)	(0.008)	(0.013)	(0.021)	(0.017)	(0.004)	(0.006)	(0.005)

	Northern Nigeria			Southern Nigeria			Malawi		
	Pooled	Women	Men	Pooled	Women	Men	Pooled	Women	Men
Uses improved seeds	0.016	0.490**	−0.016	−0.088	0.306**	−0.276**	−0.039*	0.034	−0.080***
	(0.056)	(0.238)	(0.058)	(0.091)	(0.155)	(0.114)	(0.024)	(0.038)	(0.030)
Uses organic fertilizer	0.002	0.116	0.012	−0.379***	−0.235	−0.329**	−0.026	−0.028	−0.025
	(0.041)	(0.292)	(0.041)	(0.116)	(0.222)	(0.140)	(0.020)	(0.031)	(0.026)
Uses inorganic fertilizer	0.244***	0.293	0.244***	0.303**	−0.235	0.540***	0.324***	0.289***	0.348***
	(0.046)	(0.182)	(0.048)	(0.121)	(0.229)	(0.149)	(0.021)	(0.032)	(0.028)
ln (inorganic fertilizer per ha)	0.042***	0.099***	0.036***	0.017	0.065**	−0.005	0.006*	0.006	0.005
	(0.008)	(0.031)	(0.009)	(0.016)	(0.027)	(0.020)	(0.003)	(0.005)	(0.004)
ln (organic fertilizer per ha)	0.031***	−0.078	0.033***	0.103***	0.133***	0.080***	0.014***	0.015***	0.014***
	(0.010)	(0.060)	(0.010)	(0.022)	(0.039)	(0.028)	(0.003)	(0.005)	(0.004)
Land									
Plot size	−0.241***	−0.009	−0.266***	−0.007	−0.293**	0.033	−0.094***	−0.135***	−0.086***
	(0.033)	(0.134)	(0.033)	(0.074)	(0.148)	(0.089)	(0.024)	(0.041)	(0.030)
Plot size squared	0.047***	0.060*	0.050***	0.078***	0.023	0.088***	0.029***	0.026***	0.024***
	(0.012)	(0.035)	(0.012)	(0.013)	(0.024)	(0.017)	(0.005)	(0.009)	(0.007)
Household characteristics									
HH size men	0.096***	0.082*	0.099***	0.071***	0.105**	0.059**	0.073***	0.096***	0.053***
	(0.010)	(0.046)	(0.010)	(0.022)	(0.046)	(0.025)	(0.007)	(0.010)	(0.009)
HH size women	0.019**	−0.034	0.026***	0.019	0.060	0.010	0.048***	0.062***	0.036***
	(0.009)	(0.048)	(0.009)	(0.020)	(0.039)	(0.023)	(0.007)	(0.011)	(0.009)
Has non-farm own income	−0.128***	0.229	−0.155***	0.002	−0.144	0.043	0.025	0.034	0.015
	(0.038)	(0.162)	(0.039)	(0.061)	(0.096)	(0.079)	(0.018)	(0.029)	(0.023)
Has non-farm wage income	0.019	0.390	0.021	−0.021	0.231	−0.155	0.044	0.019	0.050
	(0.059)	(0.282)	(0.060)	(0.084)	(0.143)	(0.107)	(0.029)	(0.049)	(0.036)
Distance to primary school	−0.012	0.024	−0.017**	−0.006	−0.003	−0.008	−0.000	−0.000	−0.000
	(0.008)	(0.056)	(0.008)	(0.006)	(0.009)	(0.007)	(0.000)	(0.000)	(0.000)

	Northern Nigeria			Southern Nigeria			Malawi		
	Pooled	Women	Men	Pooled	Women	Men	Pooled	Women	Men
Distance to market							−0.000**	−0.000	−0.000
							(0.000)	(0.000)	(0.000)
Distance from plot to household									
Wealth index	0.009	0.001	0.007	0.031*	0.034	0.034*	−0.008	−0.024*	0.004
	(0.010)	(0.058)	(0.010)	(0.018)	(0.041)	(0.019)	(0.007)	(0.013)	(0.008)
Received extension services	−0.071*	−0.106	−0.055	−0.053	0.002	−0.008	0.031*	−0.029	0.075***
	(0.043)	(0.253)	(0.043)	(0.109)	(0.205)	(0.129)	(0.018)	(0.027)	(0.023)
Other assistance	−0.086**	−0.039	−0.091**	0.048	0.083	0.120	−0.012	0.019	−0.040*
	(0.044)	(0.269)	(0.044)	(0.130)	(0.195)	(0.170)	(0.018)	(0.028)	(0.023)
Plot characteristics									
Number of parcels managed	−0.021**	−0.056	−0.016	0.061***	0.034	0.061***	0.003	−0.019	0.014
	(0.011)	(0.044)	(0.011)	(0.017)	(0.032)	(0.020)	(0.007)	(0.012)	(0.009)
Irrigation	−0.191*	−0.309	−0.156	0.197	0.199	0.276	0.003	0.055	−0.027
	(0.099)	(0.591)	(0.101)	(0.249)	(0.488)	(0.279)	(0.023)	(0.040)	(0.029)
Slope	−0.122*	−0.437	−0.065	−0.127	0.042	−0.248	−0.050*	−0.100**	−0.023
	(0.070)	(0.316)	(0.070)	(0.131)	(0.183)	(0.193)	(0.027)	(0.042)	(0.035)
Plot is rented	−0.063	−0.254	−0.054	0.029	0.167	−0.075	0.152***	0.197***	0.121***
	(0.074)	(0.300)	(0.076)	(0.107)	(0.181)	(0.131)	(0.033)	(0.062)	(0.039)
Gender characteristics									
Child-dependency ratio	0.052	−0.226	2.342**	−0.099	−0.237	−0.558	−0.163***	−0.177***	0.645**
	(0.164)	(0.182)	(0.997)	(0.188)	(0.231)	(0.742)	(0.032)	(0.034)	(0.264)
Female labour share	−0.075	−0.212	−0.042	−0.089	−0.090	−0.186	−0.001	−0.011	0.029
	(0.062)	(0.188)	(0.067)	(0.109)	(0.165)	(0.158)	(0.029)	(0.039)	(0.046)

Note: The results are unweighted. The estimates also include regional and crop fixed effects.

A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.001$.

Table A3. Continued

	United Republic of Tanzania			Uganda		
	Pooled	Women	Men	Pooled	Women	Men
Manager characteristics						
Sex	−0.154***			−0.297***		
	(0.050)			(0.030)		
Age	−0.002	−0.001	−0.006	0.012**	0.011	0.010
	(0.007)	(0.015)	(0.009)	(0.005)	(0.007)	(0.007)
Age squared	0.000	0.000	0.000	−0.000*	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Married manager	0.168***	0.096	0.190***	0.269***	0.156***	0.444***
	(0.044)	(0.076)	(0.057)	(0.044)	(0.057)	(0.081)
Widowed manager	−0.081	0.060	−0.161	0.151***	0.116*	−0.006
	(0.116)	(0.182)	(0.162)	(0.052)	(0.060)	(0.141)
Inputs						
ln (household family labour)	−0.571***	−0.551***	−0.580***	−0.508***	−0.452***	−0.543***
	(0.027)	(0.048)	(0.033)	(0.036)	(0.053)	(0.050)
ln (hired labour)	0.044***	0.061***	0.043***	0.033***	0.034***	0.031***
	(0.006)	(0.011)	(0.007)	(0.004)	(0.006)	(0.005)
ln (other inputs per ha)	0.010	−0.017	0.015	0.013***	0.014**	0.012***
	(0.009)	(0.017)	(0.010)	(0.004)	(0.006)	(0.005)
Agricultural Implements index	0.018	0.000	0.023	0.021**	0.039***	0.006
	(0.055)	(0.100)	(0.060)	(0.008)	(0.013)	(0.010)
ln (improved seeds per ha)	−0.001	0.018	−0.009	−0.009**	0.005	−0.020***
	(0.007)	(0.013)	(0.009)	(0.004)	(0.006)	(0.006)
Uses improved seeds	0.164***	0.099	0.187***	0.036	−0.006	0.039
	(0.039)	(0.075)	(0.048)	(0.031)	(0.057)	(0.037)
Uses organic fertilizer	0.026	−0.006	0.027	0.050	0.048	0.059
	(0.054)	(0.105)	(0.063)	(0.048)	(0.072)	(0.064)

	United Republic of Tanzania			Uganda		
	Pooled	Women	Men	Pooled	Women	Men
Uses inorganic fertilizer	−0.082	−1.417***	0.091	−0.175	−0.146	−0.208
	(0.225)	(0.508)	(0.242)	(0.131)	(0.286)	(0.147)
ln (inorganic fertilizer per ha)	0.061*	0.306***	0.026	0.030	0.037	0.036
	(0.035)	(0.079)	(0.037)	(0.023)	(0.049)	(0.026)
ln (organic fertilizer per ha)	−0.041*	−0.032	−0.047	0.041***	0.014	0.059***
	(0.025)	(0.045)	(0.029)	(0.016)	(0.026)	(0.020)
Land						
Plot size	−0.144***	−0.028	−0.168***	−0.104***	−0.085**	−0.115***
	(0.022)	(0.058)	(0.026)	(0.021)	(0.042)	(0.026)
Plot size squared	−0.006	0.037	−0.017	0.022***	0.018	0.025***
	(0.009)	(0.024)	(0.011)	(0.008)	(0.015)	(0.009)
Household characteristics						
HH size men	0.068***	0.071***	0.073***	0.060***	0.042***	0.070***
	(0.011)	(0.019)	(0.013)	(0.008)	(0.013)	(0.011)
HH size women	0.068***	0.083***	0.064***	0.062***	0.064***	0.054***
	(0.012)	(0.021)	(0.014)	(0.007)	(0.011)	(0.010)
Has non-farm own income	−0.024	−0.060	−0.014	−0.045*	−0.036	−0.050
	(0.036)	(0.072)	(0.043)	(0.025)	(0.040)	(0.032)
Has non-farm wage income	−0.102**	−0.138*	−0.082	−0.063**	−0.093**	−0.062*
	(0.043)	(0.082)	(0.052)	(0.028)	(0.045)	(0.036)
Distance to primary school				−0.017***	−0.017	−0.014*
				(0.006)	(0.012)	(0.007)
Distance to market	0.000	−0.008**	0.002			
	(0.002)	(0.004)	(0.002)			

	United Republic of Tanzania			Uganda		
	Pooled	Women	Men	Pooled	Women	Men
Distance from plot to household	0.000	0.001	0.000	0.013	0.044**	−0.007
	(0.000)	(0.001)	(0.000)	(0.012)	(0.018)	(0.015)
Wealth index	0.022**	−0.011	0.032**	0.018	0.023	0.015
	(0.011)	(0.018)	(0.013)	(0.011)	(0.016)	(0.015)
Received extension services	0.072	−0.073	0.082	−0.033	−0.016	−0.040
	(0.052)	(0.110)	(0.060)	(0.035)	(0.061)	(0.043)
Other assistance	0.049	0.116	0.009			
	(0.063)	(0.108)	(0.079)			
Plot characteristics						
Number of parcels managed	−0.018	0.048*	−0.028*	0.051***	0.045**	0.054***
	(0.013)	(0.028)	(0.015)	(0.012)	(0.018)	(0.015)
Irrigation	−0.106	−0.333	−0.017	0.133	0.167	0.086
	(0.099)	(0.208)	(0.112)	(0.085)	(0.122)	(0.117)
Slope	−0.080*	−0.155**	−0.066	0.026	0.002	0.033
	(0.042)	(0.076)	(0.051)	(0.046)	(0.065)	(0.064)
Plot is rented	0.121	0.333**	0.063	−0.023	−0.116	0.032
	(0.080)	(0.164)	(0.092)	(0.079)	(0.133)	(0.092)
Gender characteristics						
Child-dependency ratio	−0.234***	−0.188**	−0.341	−0.143***	−0.141***	0.153
	(0.062)	(0.075)	(1.421)	(0.050)	(0.051)	(0.200)
Female labour share	−0.065	−0.089	0.039	0.088**	0.012	0.063
	(0.068)	(0.103)	(0.100)	(0.044)	(0.064)	(0.069)

Note: The results are unweighted. The estimates also include regional and crop fixed effects.

A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.001$

Table A3. Continued

	Ethiopia		
	Pooled	Women	Men
Manager characteristics			
Sex	0.063		
	(0.225)		
Age	0.006	0.060	−0.016
	(0.030)	(0.084)	(0.034)
Age squared	−0.000	−0.000	0.000
	(0.000)	(0.001)	(0.000)
Married manager	0.704***	0.590	1.136***
	(0.235)	(0.473)	(0.296)
Widowed manager	−0.047	−0.674	1.193**
	(0.308)	(0.425)	(0.474)
Inputs			
ln (household family labour)	−0.823***	−0.720***	−0.867***
	(0.058)	(0.152)	(0.065)
ln (hired labour)	−0.031	−0.014	−0.028
	(0.023)	(0.044)	(0.029)
ln (other inputs per ha)	−0.050	0.044	−0.073
	(0.054)	(0.077)	(0.068)
Agricultural Implements index			
ln (improved seeds per ha)	0.105***	−0.029	0.147***
	(0.028)	(0.058)	(0.033)
Uses improved seeds	−0.291*	−0.076	−0.241
	(0.164)	(0.425)	(0.186)
Uses organic fertilizer			
Uses inorganic fertilizer			
ln (inorganic fertilizer per ha)			
ln (organic fertilizer per ha)			
Land			
Plot size	0.227	0.421	0.191
	(0.147)	(0.372)	(0.166)
Plot size squared	0.055***	0.084**	0.052***
	(0.016)	(0.035)	(0.018)
Household characteristics			
HH size men	0.032	0.070	0.066
	(0.051)	(0.131)	(0.059)

	Ethiopia		
	Pooled	Women	Men
HH size women	0.088*	0.033	0.092*
	(0.047)	(0.117)	(0.052)
Has non-farm own income	−0.435**	−0.269	−0.346
	(0.174)	(0.418)	(0.212)
Has non-farm wage income	−0.201	1.132**	−0.419**
	(0.161)	(0.458)	(0.179)
Distance to primary school	0.011	0.235	−0.013
	(0.045)	(0.143)	(0.049)
Distance to market			
Distance from plot to household			
Wealth index	0.112	0.642**	0.011
	(0.116)	(0.253)	(0.130)
Received extension services			
Other assistance	0.084	0.670**	0.051
	(0.144)	(0.332)	(0.164)
Plot characteristics			
Number of parcels managed	−0.020*	−0.049	−0.015
	(0.011)	(0.031)	(0.013)
Irrigation	−0.193	−0.627	−0.231
	(0.256)	(0.659)	(0.279)
Slope			
Plot is rented	0.332	0.658	0.270
	(0.253)	(0.882)	(0.261)
Gender characteristics			
Child-dependency ratio	−0.315	0.035	−2.226
	(0.339)	(0.539)	(3.525)
Female labour share	0.341	−0.070	0.107
	(0.300)	(0.411)	(0.400)

Note: The results are unweighted. The estimates also include regional and crop fixed effects.
A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.001$

Table A4. Kitagawa–Oaxaca–Blinder decomposition (unweighted)

	Northern Nigeria		Southern Nigeria		Malawi	
Mean gender differential						
Men	6.383***		5.369***		6.140***	
	(0.092)		(0.102)		(0.198)	
Women	6.021***		4.786***		5.727***	
	(0.212)		(0.109)		(0.121)	
Difference	0.361***		0.583***		0.413***	
	(0.124)		(0.061)		(0.078)	
Endowment effect	0.389***		0.387***		0.287***	
	(0.114)		(0.125)		(0.055)	
Structural effect	−0.028		0.196**		0.126***	
	(0.181)		(0.076)		(0.028)	
Detailed decomposition						
	Endowment effect	Structural effect	Endowment effect	Structural effect	Endowment effect	Structural effect
Manager characteristics	0.072	−0.374	0.120***	1.582	0.048***	0.047
	(0.096)	(0.623)	(0.032)	(1.267)	(0.011)	(0.308)
Household size men	0.129***	0.045	0.083	−0.087	0.050***	−0.092
	(0.033)	(0.064)	(0.055)	(0.070)	(0.006)	(0.060)
Household size women	0.016	0.171**	0.004	−0.121	−0.007***	−0.064
	(0.011)	(0.068)	(0.008)	(0.086)	(0.001)	(0.056)
Household family labour	0.229***	0.277	0.154	0.091	0.025***	−0.113
	(0.053)	(0.183)	(0.156)	(0.128)	(0.006)	(0.112)
Hired labour	0.000	0.005	0.008	−0.004	0.011***	0.002
	(0.015)	(0.009)	(0.006)	(0.011)	(0.004)	(0.006)
Inputs	0.150***	−0.618**	0.080***	0.221	0.089***	−0.113
	(0.033)	(0.245)	(0.025)	(0.148)	(0.022)	(0.081)

Land	−0.158**	0.283**	−0.175*	−0.316***	−0.048***	−0.091**
	(0.071)	(0.142)	(0.099)	(0.019)	(0.008)	(0.046)
Gender characteristics	0.017	0.116	0.032***	−0.030	0.038***	0.023***
	(0.033)	(0.085)	(0.008)	(0.178)	(0.004)	(0.008)
Household characteristics	−0.048***	−0.198***	0.022	0.028	0.006	0.012
	(0.013)	(0.028)	(0.018)	(0.090)	(0.005)	(0.052)
Plot characteristics	−0.008	0.184**	0.022*	0.032	0.007***	0.073
	(0.008)	(0.088)	(0.013)	(0.105)	(0.002)	(0.065)

Note: The results are unweighted. The estimates also include regional and crop fixed effects.
A single asterisk (*) indicates statistical significance at p < 0.05, two asterisks (**) at p < 0.01 and three asterisks (***) at p < 0.001.

Table A4. Continued

	United Republic of Tanzania	Uganda	Ethiopia
Mean gender differential			
Men	7.333***	4.491***	2.729***
	(0.084)	(0.078)	(0.098)
Women	6.864***	4.119***	2.709***
	(0.089)	(0.156)	(0.204)
difference	0.470***	0.372***	0.021
	(0.053)	(0.109)	(0.225)
Endowment effect	0.316***	0.075	0.326*
	(0.055)	(0.062)	(0.174)
Structural effect	0.154***	0.297***	−0.305
	(0.057)	(0.073)	(0.256)

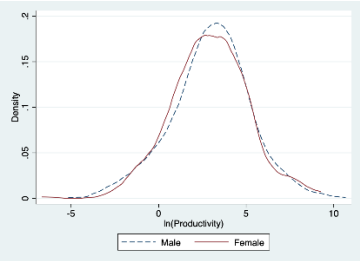
Detailed decomposition						
	Endowment effect	Structural effect	Endowment effect	Structural effect	Endowment effect	Structural effect
Manager characteristics	0.090***	−0.114	0.058***	0.192	0.241*	−1.059
	(0.026)	(0.499)	(0.019)	(0.388)	(0.140)	(3.034)
Household size men	0.070***	0.007	0.038***	0.073***	0.111	0.101
	(0.013)	(0.061)	(0.007)	(0.025)	(0.076)	(0.370)
Household size women	0.013*	−0.054	−0.011**	−0.028	0.019	0.034
	(0.007)	(0.073)	(0.004)	(0.062)	(0.023)	(0.429)
Household family labour	0.039	0.081	0.013	0.345	0.286*	0.209
	(0.029)	(0.167)	(0.023)	(0.387)	(0.149)	(0.300)
Hired labour	0.019	0.026	0.003	0.002	0.000	0.089
	(0.011)	(0.021)	(0.006)	(0.002)	(0.009)	(0.069)
Inputs	0.033*	1.296***	0.005	−0.174*	0.008	0.224
	(0.017)	(0.393)	(0.009)	(0.096)	(0.039)	(0.407)
Land	−0.062***	0.017	−0.035***	0.032	−0.248***	1.402
	(0.017)	(0.040)	(0.010)	(0.031)	(0.058)	(0.983)
Gender characteristics	0.075**	0.048	−0.003	0.041	−0.008	−0.017
	(0.030)	(0.084)	(0.020)	(0.059)	(0.028)	(0.105)
Household characteristics	0.006	0.082	−0.002	−0.087	−0.014	0.137
	(0.007)	(0.062)	(0.005)	(0.057)	(0.048)	(0.248)
Plot characteristics	−0.006	−0.254*	0.005	0.023	−0.090**	0.560**
	(0.013)	(0.151)	(0.004)	(0.077)	(0.038)	(0.254)

Note: The results are unweighted. The estimates also include regional and crop fixed effects.
A single asterisk (*) indicates statistical significance at $p < 0.05$, two asterisks (**) at $p < 0.01$ and three asterisks (***) at $p < 0.0$

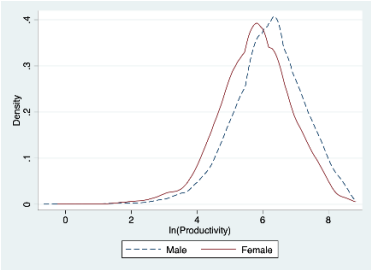
Appendix B: Graphs

Figure B1. Kernel densities of labour productivity of male and female plot managers

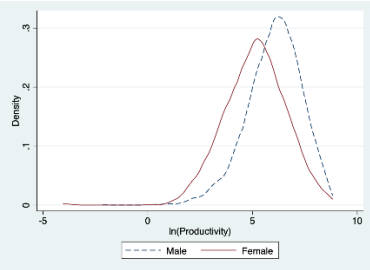
Ethiopia



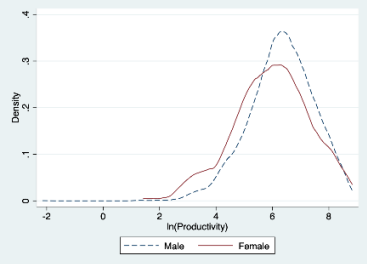
Malawi



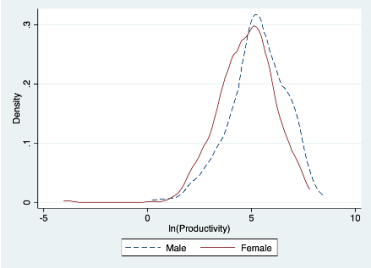
Nigeria



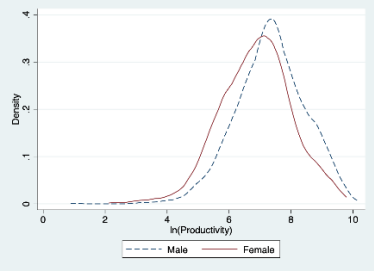
Northern Nigeria



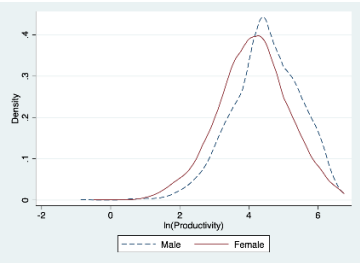
Southern Nigeria



United Republic of Tanzania



Uganda



Appendix C: Rationale

The rationale for separating the analysis between northern and southern Nigeria stems from the recognition of significant regional differences that shape gender dynamics within the country. These differences are rooted in historical, cultural and socioeconomic differences between the regions. As argued by Oseni *et al.* (2015), the decision to split the analysis for the two regions is based on the hypothesis that these cultural and socioeconomic differences are so substantial that they spill over onto gender differences.

Historically, the southern region has benefited from greater employment opportunities, urbanization and a rising human capital (GIWPS, 2023). In contrast, the northern region has faced challenges regarding infrastructure, access to education, persistent poverty and conflict. These challenges, coupled with entrenched conservative Muslim norms, have historically curtailed women's agency. For instance, Alabi and Ramsden (2021) find that women in the north are more likely to believe husbands are justified in hitting their wives than are women in the south. Women in the north are also less likely to experience financial inclusion (Central Bank of Nigeria, 2019), they earn less for the same work and have less access to land, labour and other inputs than women in the south (Enfield, 2019). Acknowledging these regional differences allows for a more nuanced understanding of the underlying drivers of gender disparities in agricultural labour productivity.

In the northern part of the country, we found that only 8 percent of plot managers were women, compared with 34 percent in the south. Managerial labour productivity was NGN 793 for the whole country, NGN 1 016 in the south and only NGN 393 in the north. If we look at the entire country together, the average gender gap is 95 percent, compared with 36 percent in the north and 58 percent in the south. In our study, we found that the endowment effect was the main contributor to the gender gap in both regions, suggesting that women in Nigeria would benefit from greater access to inputs.

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CC9118EN/1/02.24