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Gender differentials in agricultural productivity: an empirical evidence from Uganda

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Paper prepared for presentation at the 6th AIEAA Conference
"Economics and Politics of Migration: Implications for Agriculture and Food"

15-16 June, 2017
Piacenza, Italy

Summary

This paper contributes to the empirical evidence on the gender differences in agricultural productivity. Using detailed household and individual data from the Uganda LSMS-ISA (2009-10; 2010-11) we estimate the value of productivity of crops grown per acre of harvested land at the household level, based on the gender of the land manager. Results from the Tobit model with fixed effects confirm the findings of the existing literature: controlling also for socio-economic variables and plot characteristics (soil quality, topography, distance from the homestead), as well as for the use of inputs (both labour and other inputs than labour) female managed plots are less productive than plots managed by men. Better individual agricultural data disaggregated by gender may allow to better identify the reasons of such productivity gap.

Keywords: agricultural productivity, gender gap, land, Uganda.

JEL Classification codes: J16, J43, Q12.

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1. INTRODUCTION

Traditional agriculture in Sub-Saharan Africa is characterized by gender division of labour in tasks and crops (Ezumah and Di Domenico, 1995). Albeit women are the productive partners of men in agriculture (Oladejo et al., 2011), they are still subjected to an "assets discrimination": besides control over land, access to fertilizer and other inputs, also extension and training services for improved technologies are denied to them.

Since the 1970s, a considerable body of the literature has emphasized the role of women in the agricultural production (Salome, 2014; Elbehri and Lee, 2011; Elad and Houston, 2002; Warner, 2000; Quisumbing, 1996; Udry, 1996; Bassett, 1993; Blevins and Jensen, 1991). The lower productivity of female headed farms is a much-debated issue. The main reasons of this gender gap can be attributed to gender differences in: a) access to and control over agricultural inputs; b) tenure system, credit and extension services constraints, that affect investments on technologies; c) informal rules that influence the management and marketing of the agricultural output (Kilic *et al.*, 2015). Studies in this vein show that yield differentials are partly due to gender-specific assets and to the credit constraints women face (Thapa, 2008). Also, FAO (2011) has recognized that equal access to productive resources "could increase yields by 20-30%" (FAO, 2011). Since land is one of the most important economic resource, the recognition of its entitlement may be relevant for increasing productivity (Masterson, 2007). In fact, its ownership motivates farmers to "make efficiency-enhancing improvements" (Masterson, 2007) towards technical investments (for example, by the introduction of improved seeds or machineries). Rural women farmers are crucial for food production and food security (Salome, 2014). Aside from the inside home tasks, if men are considered as the main responsible of cash crops, women are viewed as the most accountable for the production of subsistence food for home consumption (Doss, 2002). However, despite their vital role in agriculture and food security, women continue to have lower access to a range of productive resources, information and financial assets. This discrimination has direct consequences for land productivity (Koru and Holden, 2008).

Measuring gender differences in productivity is cumbersome, due to the complexity of farming systems, as well as to the lack of data on inputs and outputs disaggregated by gender. Indeed, plot level information separated by gender management would be essential for this analysis. Moreover, confusion about notions of sex and gender contributes in complicating this kind of analysis. As stated by Quisumbing (1996) "sex differences are due to innate biological differences between men and women. Gender differences, [...] arise from the socially constructed relationship between men and women" (p.1580). Furthermore, this difficulty is also linked with a variety of farming systems, so that estimating these differences in plots managed jointly by men and women is more complicated (Njuki *et al*., 2006).

A common limitation of studies measuring the gender differences in agricultural productivity is that they rely on proxies of individual access to assets and inputs, and this is one major reason why results are only partially representative of the individual productivity.

Therefore, this article sets out to investigate the extent to which gender differences exist in agricultural productivity, and whether land ownership and management may influence this gap. In this study, knowing that land ownership could not be a sufficient condition for explaining possible differences between plots managed by female and male owners[1] , we decide to combine land ownership, access and use of plots, and agricultural output management as the gender land indicator.

Data for this study are drawn from the 2009-10 and 2010-11 waves of the Uganda Living Standard Measurement Survey- Integrated Survey on Agriculture (LSMS-ISA henceforth). We use the Agricultural Questionnaire, that contains information about the farm management, the inputs use and the output at the household level. To recover as much individual information as possible, we combine the household level information drawn from the agricultural dataset with the individual information available in the household dataset. This allows us to consider also socio-demographic individual indicators, such as age, education, household size and gender composition of the agricultural household. In this paper, the analysis will be focused on Uganda, a country where agriculture represents a core sector of the economy and where, according to FAO, there is an almost egalitarian participation of men and women in the agricultural activities[2] . The production system is based on smallholder subsistence farming, dominated by food crops, such as plantains (mainly known as “matooke”), cereals, cassava and oil crops.

Table 1 illustrates the distribution of primary crops, disaggregated by plot manager. What stands out in the table is that plots controlled by women achieve higher outputs, at least for matooke, potato, cassava and sorghum, which are mainly subsistence crops. Instead, male-managed plots are more likely to reach higher quantities of harvest for maize, cereals and other food crops. This last category includes, among others, coffee, tea and cotton, that constitute the main share of the country exports. In other words, the table reflects the gender division in agriculture: whereas women deal with subsistence food, in line with their responsibility for the household food intake, men mainly handle cash crops.

Table 1. Crop distribution (%) by gender of the plot manager.

Crops	Plots managed by women	Plots managed by men
Matooke	19.21	14.81
Potato	10.00	8.19
Cassava	14.28	13.41
Maize	16.14	21.61
Sorghum	5.17	3.69
Cereals	3.77	4.55
Fruits & Vegetables	3.37	3.68
Beans	15.31	15.57
Other	12.76	14.49
Observations	669	1940

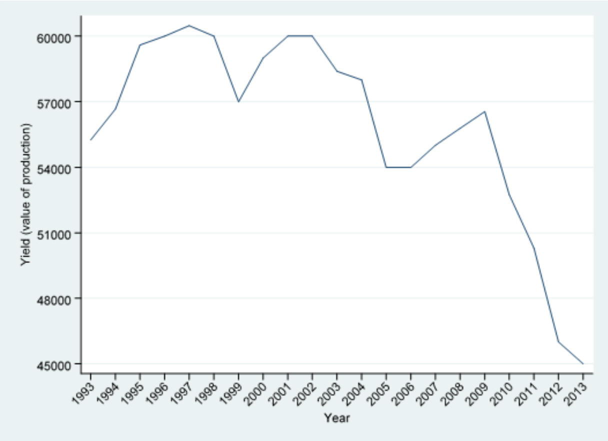
Source. Author’s calculation.

[1] This statement could be more valid for women, who in the case of ownership, acquire land through inheritance. Moreover, ownership does not automatically imply management since land could be rented-out, so that productivity depends on external factors not directly imputable to the landowner, such as the use of fertilizers or other inputs.

[2] For more information, see **www.fao.org.**

Matooke is the most important staple food in Uganda, representing the basic food for the Ugandan people diet. Over the last two decades its agricultural productivity has shown a fluctuating trend, as Figure 1 below shows, with a decreasing trend since the start of the food price crisis.

Figure 1. Uganda annual yield of matooke (1993-2013)



Source: FAOSTAT. Accessed on May 19, 2017.

The paper models gender differentials in agricultural productivity using a Tobit approach with fixed effects[3]. Findings reveal that gender differences exist in crop productivity, suggesting that plot-level productivity is lower in female-headed plots, possibly due to the many constraints women face (access to inputs, credit, extension services). The paper is structured as follows. We first give a brief overview of the literature related to gender productivity. We then turn to model (Section 3) and data description (Section 4). We present our results and their discussion in Section 5. Section 6 concludes with suggestions for further research and policy implication.

2. RELATED LITERATURE

The literature investigating differentials in agricultural productivity by gender is growing. Since Boserup's *Woman's role in economic development* (1970), many studies have tried to assess the role of women in agriculture.

The existing evidence on gender differentials in agricultural productivity, is mixed: if one set of empirical studies agrees on the lower level of productivity of women (Djurfeldt *et al*., 2013; Bezabih and Holden, 2010; Holden *et al*., 2001; Udry *et al.*, 1995; Jacoby, 1992), another set has found no significant differences between productivities of male and female farmers. Djurfeldt *et al*. (2013) demonstrated that in sub-Saharan Africa only 15% of the landholdings are held by women who, due to their limited access of inputs, reach lower levels of yields. Similarly, Koru and Holder (2008) observe yield differentials between men and women, identifying the causes in the discrepancies of the resource endowments, inputs use and market access. This view is also shared by Tiruneh *et al.* (2001), who pointed out that, if male and female headed households had the same access to inputs, their level of productivity may likely be the same. In the same line, Alene *et al.* (2008) claims that men and women farmers are equally efficient as farm managers, and their responsiveness to price incentives is alike. Contrariwise, Akresh *et al.* (2005) concludes that plots managed by women are less

[3] As the Tobit model in STATA 13 does not contemplate fixed effects, we implemented the Honoré (1992) pantob estimator.

productive than the ones controlled by men, even after controlling for observable peculiarities of the plot, such as the plot size[4]. This result is also offered by Aly *et al.* (2010) who, however, controlling for differences in irrigation and use of improved seeds, report that such differences reduce and become insignificant. In a similar manner Mèdagbè *et al.* (2010) suggest that, although women reach a lower level of productivity since they lack control over productive resources, they are as technically efficient as men. As Quisumbing states (1995), few studies related to this issue "control for individual endowments by gender, and even fewer for relationships between individual characteristics (for example, education, [...]) and input choice" (p.3), leading to possible overestimated differences in productivity due to gender.

Quisumbing (1995) demonstrates that female farmers are as equally efficient as the male ones (in six of the seven country studies she reviews, in fact, the coefficients are insignificant, except for Burkina Faso). Also Adesina and Djato (1997) pointed out that female rice growers in Côte d'Ivoire are as efficient as men. In part, these results are associated to the nature of data used in the related empirical research: as will be explained later, in fact, agricultural surveys are mainly administered at household rather than at individual level, so it is often difficult to identify the gender of the plot manager or owner. Farther, most of these studies use the sex of the household head as the unique gender indicator. However, even if this issue may be addressed through individual data on household members (as in the case of the LSMS-ISA), obtaining information on the use of inputs by gender is harder. One of the possible implications is that female farmers outcome may be underestimated, leading to the consideration that they are less productive than men, not accounting that the allocation of resources may be Pareto inefficient within the household itself.

Land productivity, which is the total output divided by size of the farm, is the traditional measure used in this field of analysis (Lastarría-Cornhiel, 1988), although the criticism due to the focus on one input as land (Masterson, 2007). Since land plays a pivotal role in agriculture, and due to the fact that in developing countries women are often excluded from its control, emphasizing the role of gender gaps in land ownership/management could help in explaining the gender gap in agricultural productivity. In this regard, Foltz *et al.* (2000) assert that insecure property rights "reduce investments in land management, productive assets, and new technologies". However, also in this strand of literature, the findings are mixed: Bellemare (2013), for example, suggests that formal land titling does not affect productivity in Madagascar, even though the rights to leasing out land is negatively associated to it. In this vein, the Fast Track Land Reform Programme (FTLRP) in Zimbabwe has not been accompanied by a raise in agricultural production (Zikhali, 2008). On the other hand, Anyaegbunam *et al.* (2010) show that land ownership is positively associated to agricultural productivity in Nigeria. This view is also supported by Alsop *et al.* (1996). In line with this, the study of Bezabih and Holden (2010) reports that, while land certification impacts positively on plot-level productivity, however the effect is more pronounced for male-headed households than for female-headed ones. Furthermore, some studies (Place and Migot-Adholla, 1998; Carter and Olinto, 1996) shed light on the potential endogeneity of land titling, and on the problem of the potential spurious correlation between land tenure and productivity if endogeneity is ignored. Even though owning land may increase investment on it, in this paper we assume that land ownership is not a sufficient condition for explaining gender trends in agricultural productivity. Indeed, as land ownership for women is highly associated with inheritance, in order to examine more closely the links between gender, land and agricultural productivity, we combine land ownership, access and use of plots, and agricultural output management, deriving the variable of "plot manager", and using the sex of the plot manager (as we will describe later) as a gender indicator.

[4] Since women control less land than men, plot size is another relevant issue to be explored when analysing differences in gender productivity. Overall, plots managed by women are smaller than the male ones, engraving the output harvested.

2.1. Land Tenure system

Land ownership is a relevant issue, particularly in rural contexts, where livelihoods are highly dependent on agriculture. In many parts of the world, women obtain access to land through the male components of the family (husbands, fathers or sons), even though land titling is generally allowed only to men (Doss et al., 2014) and this is also the case of Uganda. There, as in most countries of sub-Saharan Africa, women inherit land only in exceptional circumstances (i.e. when there are no male heirs, see Asiimwe, 2014. There are some exceptions to this general rule, depending on the specific country legislation: for example, in Nepal the Eleventh Amendment of the Constitution partially extends the possibility to inherit and own land also to female individuals).

However, when dealing with land rights, it is useful to explore the conceptual and empirical distinction between ownership and access over land (Lastarria-Cornhiel, 1997): land ownership, in fact, implies rights related to the control and decision over production, while the access to land is related to its use, without any decisional right over production. The Uganda Land Act of 1998 disciplines the land tenure, ownership and management of the land. It held the four historical types of land tenure: freehold, leasehold, mailo and customary:

- freehold is the ownership of land that guarantees full power of use and “the compulsory registration of title in perpetuity” (GoU, 2013).
- leasehold is a way of tenure that, as freehold, “referred to as individual tenure” (Okuku, 2006). It grants a person to take possession and using land for a specified or limited period. These rights are bestowed by an agreement with the owner of the land, according to certain conditions and payment of a rent.
- mailo was created during the colonial period, through the 1900 Buganda agreement. The land ownership was given to the Buganda chiefs and notables (Deininger *et al.*, 2008). It permits the separation between the separation of land from the ownership by a lawful or bona fide occupant, enabling the holders to exercise all the powers of ownership;
- customary is a traditional ownership tenure system. In this case land may be owned by the community, clan, families or individuals. Landholders under this system do not have a formal land title, although “All Ugandan citizens owning land under customary tenure may acquire certificates of ownership [...] of customary tenure” (Article 237(4)(a) of the 1995 Constitution and Section 4(1) of the Land Act, 1998).

A further amendment introduced the concept of “family land”: land is considered the source of livelihoods for the household members, and it cannot be transferred without the consent of all the individuals depending on it, including women and children (Deiningen *et al*., 2008). The article 33 of the Uganda Constitution states that women shall be accorded equal rights and treatment as men, including equal opportunities in political, economic and social activities (Constitution of the Republic of Uganda, 1995). As Doss *et al.* (2014) pointed out, the type of customary land may influence the farmer’s behaviour, in terms of long-term interest and investments.

3. MODEL DESCRIPTION

To assess the extent of possible male-female differences in the agricultural productivity in Uganda, we estimate the productivity as a measure of the value of all the crops produced at the household level per acre of land under cultivation. Following Owens *et al*. (2003), this is carried out by multiplying the physical quantities of all the crops produced per acre (converted to kilograms) by their unit price, aggregating crops production across plots[5] . The unit price has been calculated for each household, by dividing the value of the total sales by the overall quantity sold. Whether missing were present, due probably to the lack of food sold, we imputed productivity considering the median price of the district where the household lives. The value of the multi-crop productivity is expressed in Ugandan shilling. Farther, although the low number of observations, we also estimate the value of productivity for the main crops produced, namely matooke, cassava, potato (both sweet and Irish), maize and beans, reporting findings in the Appendix.

As the scope of this study is to investigate gender differences in agricultural productivity in Uganda, we propose to introduce the gender of the "land manager" as a gender indicator. It considers both the head of the household head, and of his/her spouse. More specifically, with the notion of "land manager" we refer to the person who, in each household, has the ownership and right use of plots, and who manages the output. In detail, we create three measures of plot managing (they are all dummies), one complementary to the other ones, even though the empirical analysis has been carried out using land management:

- gender land ownership: it is the basic index of land titling, which assumes the value of 1 whether land is owned by the female head or spouse, and 0 for their male counterparts;
- gender land ownership and use: in this case, we attribute the value of 1 to all plots where women exert not only a property right, but have the right to use it. This is a fundamental assumption, particularly in contexts where the land entitlement is not automatically associated to the asset use, and this is especially evident for women;
- gender land ownership, use and output management: this variable is derived by the integration of the plots output management with the ownership and use of plots. In fact, we consider that land ownership itself and land use may not be sufficient conditions in explaining the gender differences in agricultural productivity. In effect, since women are often excluded from the agricultural production management and from the output selling, we assume that the participation in the output management might explain possible gender gaps in the agricultural productivity[6] . For the explained reasons, the empirical model has been implemented using the gender of the plot manager. In detail, we create a binary variable, taken the value of 1 if household plots are owned by female head or spouses, they have the right to access and use them, and the right to manage the agricultural output, and 0 for men.

Farther, differently from the existing empirical studies on this field, that use only the sex of the household head as a gender indicator (mainly because gender-disaggregated data on access and use or ownership of the plots are often recorded at the household level, and the household head is often the respondent of the questionnaire), we extended our analysis to both the household head and his/her spouse. This is a relevant issue, even because restricting the analysis to the household head might be narrow: in countries such as Uganda, indeed, most of the households are headed by men, so that many women would be excluded and gender bias in productivity might be overestimated.

However, to avoid possible biases deriving from the overlapping in the land management between the head of the household and his/her spouse, we control for the cases of "mixed land management". We find that few plots are managed by both of them simultaneously, but we get rid of them in order to not distort the final results.

[5] The agricultural questionnaire records data at both the plot and parcel levels. Despite the presence of multiple plots, most of the information collected mainly concerns the "plot 1". However, to avoid the loss of data available for all the plots cultivated by each household, we aggregated all the data about both input and output across plots.

[6] However, we control for possible differences between landowners and plot managers by gender, finding that in most of the households' landowners at the same time manage the output.

3.1. Empirical Specification

Following the existing literature on this field, the Cobb-Douglas production funtion is used by taking the logarithms on both sides of the equation, as drawn below:

$$lnY_{ij} = \alpha_0 + \alpha_1 T_{Gj} + \beta \ln I_j + \tau \ln L_j + \gamma S_j + \sigma H_i + \epsilon \quad (1)$$

where Y_{ij} is the logged value of total crops produced (per acre) in the j^{th} plots managed by the i^{th} male or female land manager, T is the land manager of plots j, differentiated by gender, I is the log of the quantity of inputs used (expressed in kilograms), namely organic and inorganic fertilizers, and pesticides, per acre of plots, L is labour input (family and hired, measured in person days)[7], S is a vector of land characteristics (soil type and quality, topography and water sources), indexed by the j_{th} plots[8], and ϵ is the error term.

It is important to bear in mind that we are estimating a measure of partial differences in gender productivity (as Quisumbing, 1995, suggests). A wider analysis requires specific data on crops grown by women, and on inputs access and use disaggregated by gender, not available in this survey[9]. Usually, the Cobb-Douglas production function is estimated by an Ordinary Least Squares (OLS) model. However, in this specific case, the productivity measure contains a consistent number of zero values, which may occur for different reasons. For example, the plots could have been cultivated, but not harvested yet at the time of the visit. Alternatively, the cultivated crops could have been lost due to adverse whether shocks, pests or other natural disasters[10]. Moreover, the area could have been left fallow to improve soil quality[11], or used as pasture or grazing land, or abandoned due to economic inability to cultivate it (e.g. high cost of inputs) (Peterman *et al.*, 2011). For these reasons, rather than dropping plots for which zero productivity is observed, the panel censored regression model has been implemented, as it may be the most suitable econometric procedure given the left censoring of the dependent variable at zero (Tobin, 1958; Honoré, 1992).
The model we estimate is therefore the following:

$$ln\ Y_{ij}^* = land\ management_{ij} + \beta X_{ij} + \alpha_i + \varepsilon_{it} \quad (2)$$

$$lnY_i = Y_i^*\ if\ Y_{ij}^* > 0$$
$$lnY_i = 0\ if\ \ Y_{ij}^* \leq 0$$
$$i = 1, \dots, N\ and\ \varepsilon_{it} \sim (0, \sigma^2)$$

where i and j are the indices for individuals and plots respectively, Y is the indicator of the plots-level productivity, Y^* is the latent dependent variable, that is equal to the observed Y if Y^* is higher than zero, *land*

[7] Following Tiberti and Tiberti (2015), due to the presence of zero values in all the inputs data, we computed the logarithmic form by adding one to all the original values, to then transform them.
[8] The plot characteristics indices are in a binary form, to make their interpretation more straightforward, as the questionnaire codes each of them in a categorical form.
[9] Eventually, we could have extrapolated these information on the basis of the plot manager. However, we implemented the model also separately for male and female plot managers, but many of the control variables were dropped once the model was run.
[10] An explicit question was asked to households about the quantity lost, but it refers to the unit of crops already harvested.
[11] At this regard, we introduce a binary index for fallow plot as a control variable. Results are reported in Appendix.

management is the plot management indicator, differentiated by gender, X is the vector of household and plot characteristics, α_i is the individual effect, and $_{it}$ is the error term, assumed to be independent and identically distributed (i.i.d) as a Normal distribution, with zero mean and fixed variance, and N is the number of observations (Ai *et al.*, 2015; Peterman *et al.*, 2011; Gourieroux, 2000; Maddala, 1987). When considering a model with panel data, the error term ϵ_{it} can be decomposed into:

$$\epsilon_{it} = \alpha_i + \lambda_t + u_{it} \quad (3)$$

where α_i is the individual effect (representing all the unobservable characteristics specific to the unit i, assumed constant over time), λ_t is the time effect (indicating all the unobservable characteristics of time period t, constant for all the cross-sectional units in the sample), and u_{it} is a random term that varies over time and individuals (Calzolari *et al.*, 2001). However, Tobit is a random-effects model, that does not control for the unobserved heterogeneity. For this reason, we implemented a Tobit model with household fixed effects (Honoré, 1992). For robustness check, we also computed the random-effects model[12], that confirm the main findings.

4. DATA

We use the Uganda National Household Survey (2009-10 and 2010-11), a nationally-representative household survey implemented by the Uganda Bureau of Statistics (UBOS, henceforth), with the support of the World Bank Living Standard Measurement Surveys -Integrated Survey on Agriculture (LSMS-ISA) program[13] . The survey is conducted annually on a nationally representative sample of households, which are visited twice over the year, separately for the dry and rainy seasons, in order to better capture seasonal information about consumption and agricultural outcomes[14]. The first visit goes from January to June, while the second season hold from July to December. However, we aggregate data across the two seasons.

For the purposes of the research, some sections of the household questionnaire are integrated with the agricultural ones. The first survey sections provide information on the demographic and socio-economic characteristics of the households (age and gender of the household head, education, income and employment, expenditure, exogeneous shocks). The second ones contain information on the agricultural activities, at both the plot and parcel level, about holdings, land quality and soil characteristics, crops planted and harvested[15] and its uses (sales, home consumption and stocks), labour[16] and non-labour[17] inputs used, livestock ownership. In the agricultural survey questionnaire data are gathered at the plot and parcel level for each household. From the two survey questionnaires (household and agriculture), we get a full balanced panel of 3.254 households. Nevertheless, we restrict our attention on plots managed by women and men. Therefore, the selection of plots for which data on land management are available lead to a reduced sample of 2866 households.

[12] Findings available upon request.
[13] For more details, see the Uganda National Panel Surveys, Basic information document, available at **http://econ.worldbank.org/.**
[14] In principle, the questionnaire is answered by the household head or, in his/her absence, by an adult member of the household. However, in our sample is mainly the household head who provide the requested information.
[15] All the quantities of output are recorded in local units, and converted in kilograms.
[16] Both family and hired labour, measured in time units (days spent on farming activities). Hiring days are provided for men, women and children.
[17] Organic and chemical fertilizer, pesticide, improved seed, access to extension and advisory services.

Among the full Ugandan sample, approximately the 26 % of all plots are managed by women, compared to the 74% of plots managed by men.

Table 2 shows the summary statistics regarding the quantity and value of productivity and inputs used, decomposing them on male and female-managed plots. They clearly confirm the existence of a gender gap: in fact, the value of output per acre is lower in female-managed plots respective to the male one. Moreover, the size of plots managed by women is, on average, smaller than the plots managed by men. At the same time, female managers tend to inherit or purchase land less than the male ones. This result suggests that the land market marginalizes women: land titling is still mainly transmitted on a male basis, and women have lower rights to participate to market transactions. In terms of inputs applied, male-managed plots make use of a higher share of non-labour inputs: specifically, the quantity (in KGs/acre) of both the organic and chemical fertilizers is particularly high in male-managed plots, although the difference in the use of pesticides between male and female-managed plots is very low. Similarly, improved seeds are more likely to be used in plots managed by men. Data further show that extension and advisory services are provided more to men than to women. Interestingly, female-managed plots seem to employ more labour inputs than the male ones. This pertains mainly family labour, probably thanks to its easier access.

As concerns the labour time, statistics illustrate that, not surprisingly, men devote a larger working time to agricultural activities, whilst on average women spend more hours of work in the domestic tasks.

Table 2. Descriptive statistics.

	Female-managed (N=742)		**Male-managed (N=2124)**	
	Mean	**S.D.**	**Mean**	**S.D.**
Crops grown				
Total crops produced (KG)	72.39	[89.02]	97.34	[255.75]
Value of total productivity (KG/acres) in Shillings (log)	7.11	[7.03]	8.38	[7.00]
Socioeconomic indicator				
Age of the plot manager	53.84	[14.75]	47.39	[14.41]
Head no education†	0.34	[0.47]	0.08	[0.28]
Head primary education†	0.59	[0.49]	0.82	[0.39]
Head secondary education†	0.05	[0.22]	0.08	[0.26]
Head higher education†	0.01	[0.09]	0.01	[0.10]
Household size	5.91	[2.96]	7.20	[3.20]
Number of male children	1.04	[0.25]	1.04	[0.21]
Number of female children	1.04	[0.21]	1.03	[0.16]
Number of male adults	1.71	[1.06]	1.78	[1.09]
Number of female adults	1.80	[1.02]	1.60	[0.90]
Land characteristics				
Distance from the homestead (index)	2.04	[1.23]	2.00	[1.18]
GPS-based plot size (acres)	3.93	[22.82]	4.96	[28.62]
Irrigated (acres)	0.26	[2.11]	0.25	[2.31]
Intercropped†	0.41	[0.49]	0.44	[0.50]
Pure stand†	0.33	[0.47]	0.29	[0.45]
Good soil quality†	0.71	[0.46]	0.75	[0.43]
Fair soil quality†	0.50	[0.50]	0.48	[0.50]
Land located in hilly †	0.13	[0.34]	0.15	[0.36]
Land located in flat †	0.55	[0.50]	0.60	[0.49]

Table 2. Continued.

Land located in valley†	0.06	[0.23]	0.06	[0.24]
Agroecological zones†				
Savannah	0.04	[0.20]	0.03	[0.18]
Arid and semiarid	0.08	[0.27]	0.07	[0.26]
Highlands	0.05	[0.22]	0.06	[0.24]
Land tenure				
Proportion customary land (%)	0.55	[0.49]	0.54	[0.49]
Proportion freehold land (%)	0.41	[0.48]	0.42	[0.48]
Proportion mailo land (%)	0.04	[0.21]	0.03	[0.17]
Modality of land acquisition†				
Land inheritance	0.14	[0.34]	0.35	[0.48]
Land purchase	0.07	[0.25]	0.20	[0.40]
Non-labour inputs				
Organic fertilizer (KG/acre)	12.25	[98.85]	22.88	[346.67]
Chemical fertilizer (KG/acre)	0.01	[0.21]	0.09	[2.13]
Pesticide (KG/acre)	0.08	[1.65]	0.04	[0.77]
Improved seeds†	0.10	[0.30]	0.16	[0.36]
Cattle ownership†	0.33	[0.47]	0.41	[0.49]
Extension services†	0.08	[0.27]	0.11	[0.31]
Advisory services†	0.20	[0.40]	0.26	[0.44]
Labour inputs				
Family labour (person days per acre)	30.06	[45.88]	27.19	[57.63]
Hired men labour (person days per acre)	1.31	[3.11]	1.04	[1.86]
Hired women labour (person days per acre)	2.05	[2.82]	1.59	[2.19]
Annual agricultural hours of work	278.50	[375.09]	312.83	[380.23]
Annual domestic hours of work	287.74	[275.58]	238.65	[184.24]
Shocks†				
Crop damage	0.49	[0.50]	0.52	[0.50]

Source: Author's elaboration.
†Dummy variables.

5. RESULTS AND DISCUSSION

We have estimated the Tobit model with household fixed-effects by using the Honoré pantob routine in Stata 13[18]. For robustness check, we have also estimated the Tobit model with random effects for all the model specifications. Results are available upon request.

The findings obtained are set out in Table 3. The three columns report respectively the baseline model and two additional specifications. The baseline model considers the gender indicator, the household and plot characteristics, the inputs used and whether the household has been affected by a crop damage. In the second

[18] It is a Gauss program that estimates a censored Tobit model with panel data. The program is available at **http://www.princeton.edu/ honore/stata/.**

specification, we maintain all the indicators, with the addition of the agroecological zones. Finally, the third model includes further information on domestic annual hours of work and the modality of land acquisition.

The evidence provided here demonstrates that plots managed by women achieve lower levels of productivity than the ones managed by men. This lower value of productivity may be indicative of the wider inequalities in the access and distribution of inputs among female and male farmers. In fact, it is important to note that, although their active role in farming activities, women face much more constraints in the access to factors of production.

Plot size is highly significant and positively related with land productivity in all models, as well as plots with a good soil quality, and that are in hilly regions. It is also found that cattle ownership significantly raises the value of productivity. This result may be attributed to the use of livestock as tools in the soil processing. Contrarywise, the use of fertilizers (both chemical and organic) has not a statistically significant effect, except for pesticide, that is associated to a positive increase in the value of agricultural productivity in the third specification model. Surprisingly, controlling for the extension services (namely, NGO, cooperatives, input suppliers, and other extension service providers), the negative coefficients reveal that, on average, farming households who benefit from extension services and which are managed by men are less productive.
Family labour is found to enhance the value of productivity, in contrast with hired female labour, that is associated with lower productivity outcomes. This is consistent with the basic hypothesis that female farmers bear the cost of a narrow inputs access.

The analysis of agricultural productivity cannot ignore the role of agro-ecological zones (*AEZ*, henceforth). According to FAO, Uganda can be divided into seven *AEZ*, with similar ecological conditions (soil type, topography, rainfall), farming systems and practices. Even so, following Wasige (2009), and due to the availability of data, we divided Uganda into three broad agro-ecological zones: savannah, arid/semi-arid and highlands[19]. Therefore, we include them into the baseline model specification. Findings suggest that the regional ecological zone has not an impact statistically significant for the value of crop productivity.

Finally, where we include the annual domestic annual of work and the modality of land acquisition, we find that there is no statistical significance association with the value of productivity.

Considering the socioeconomic characteristics, the regression results are quite revealing. The level of education of the female-head of the household is significantly associated to a decrease in value of agricultural productivity, as well as the age of the plot manager. Contrariwise, higher output values are driven by larger households, due to the availability of a number of people to be employed in the farming activities.

[19] For more details, see Wasige, 2009, p.7.

Table 3. Tobit with fixed-effects regression results.

	(1) Baseline		(2) Agroecological zone		(3) Hours of work & Land acquisition	
Plot manager (female = 1)	-7.171***	[-3.51]	-6.934***	[-3.32]	-10.844***	[-4.96]
Socioeconomic indicator						
Age of the plot manager	-1.620***	[-3.20]	-1.599***	[-3.00]	-2.811***	[-5.65]
Female head primary education†	-5.218***	[-2.67]	-5.348***	[-2.73]	-9.503	[-1.28]
Male head primary education†	-0.060	[-0.03]	-0.197	[-0.10]	0.856	[0.36]
Female head secondary education†	-0.683	[-0.08]	-0.801	[-0.09]	5.324	[.]
Male head secondary education†	-1.241	[-0.42]	-1.399	[-0.47]	1.019	[0.21]
Household size (log)	26.443**	[2.51]	29.772**	[2.49]	-119.252	[.]
Land characteristics						
Distance from the homestead (index)	-0.304	[-1.28]	-0.296	[-1.25]	0.095	[0.31]
GPS-based plot size (log of acres)	1.280***	[2.76]	1.302***	[2.78]	1.424**	[2.06]
Irrigated land†	-1.719	[-1.27]	-1.585	[-1.18]	-1.534	[-0.98]
Intercropped†	0.759	[1.49]	0.784	[1.54]	0.362	[0.53]
Good soil quality†	1.821***	[2.68]	1.848***	[2.75]	0.962	[1.17]
Fair soil quality†	-0.097	[-0.18]	-0.117	[-0.22]	-0.186	[-0.29]
Land located in hilly†	1.489**	[2.47]	1.525**	[2.48]	1.104	[1.48]
Land located in flat†	0.282	[0.48]	0.270	[0.46]	0.509	[0.64]
Land located in valley†	0.774	[0.96]	0.758	[0.94]	1.332	[1.54]
Land tenure						
Proportion customary land (%)	0.495	[0.31]	0.416	[0.26]	-1.033	[-0.55]
Non-labor inputs						
Organic fertilizer (log of KG/acres)	-0.165	[-0.84]	-0.170	[-0.82]	-0.093	[-0.44]
Chemical fertilizer (log of KG/acres)	0.498	[0.28]	0.439	[0.24]	0.161	[0.20]
Pesticide (log of KG/acres)	1.631	[1.14]	1.650	[1.16]	3.372***	[3.30]
Improved seed†	1.008	[1.21]	0.942	[1.14]	0.243	[0.25]
Cattle ownership†	2.703***	[3.55]	2.771***	[3.64]	2.273**	[2.56]
Extension services (women)†	-0.172	[-0.05]	-0.063	[-0.02]	4.245	[1.13]
Extension services (men)†	-2.156**	[-2.29]	-2.067**	[-2.26]	-1.485	[-1.38]
Advisory services (women)†	2.428	[1.47]	2.412	[1.43]	5.742*	[1.93]
Advisory services (men)†	-0.441	[-0.57]	-0.532	[-0.70]	-0.630	[-0.74]
Labor inputs						
Family labor (log of person days per acres)	0.788*	[1.94]	0.759*	[1.90]	1.300**	[2.32]
Hired men labor (log of person days per acres)	0.667	[0.51]	0.713	[0.55]	0.167	[0.08]
Hired women labor (log of person days per acres)	-1.878*	[-1.74]	-1.863*	[-1.79]	-3.097**	[-2.07]
Shocks						
Crop damage†	0.578	[1.01]	0.578	[1.01]	-0.398	[-0.59]
Agroecological zones						
Arid and semiarid†			-2.581	[-1.17]		
Highlands†			1.607	[1.07]		
Domestic hours of work (log)						
Women					0.157	[1.27]
Men					0.066	[0.47]

Table 3. Continued.

Modality of land acquisition†						
Land purchase (women)					5.721^{*}	[1.73]
Land purchase (men)					0.911	[0.95]
Observations	2633		2633		1464	

*p<0.10, **p<0.05, ***p<0.001.
Source: Author's elaboration.

6. CONCLUSION

In this paper, we aim to contribute to the growing literature on gender gaps in agricultural productivity. Notwithstanding the usual data limitations encountered in gender analyses, our study adds to the literature, introducing the new perspective of plots managed by men and women.

Given the limits that this strand of research faces, due to the lack of gender disaggregated data about land ownership and management, we have been able to build a gender indicator of plot management, thanks to the household section of the Living Standard Measurement Survey - Integrated Survey on Agriculture (2009-10 and 2010-11) for Uganda. We find that plots managed by women seem to be less productive than plots run by men. Unfortunately, data about the access to and the use of inputs are at household level. Therefore, it is difficult to identify the actual reasons of the lower value of crop productivity we have found in female-managed plots. For instance, because of the lack of gender differentiated data on crops grown by women and men respectively, the measure of productivity we have computed is only a partial indicator of the gender differentials in productivity.

Nevertheless, more research is recommended to support agricultural productivity and sustain the livelihood of rural farmers, without forgetting the relevance of gender as a dimension able to enhance economic growth and food security in rural areas.

AKNOWLEDGMENTS

This article is a modified version of a paper of the author's PhD thesis. Therefore, the author thanks Gianna Claudia Giannelli for comments on a preliminary version.

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