SAJE South African Journal of Economics
ESSA The Economic Society Of South Africa (Est. 1925)
South African Journal of Economics Vol. 87:2 June 2019

CONTRACT FARMING IN MOZAMBIQUE: IMPLICATIONS FOR GENDER INEQUALITIES WITHIN AND ACROSS RURAL HOUSEHOLDS[‡]

CECILIA NAVARRA[†,*]

Abstract
This paper analyses the implications of contract farming for gender inequalities in rural Mozambique. Contract farming is often considered one of the major tools of agribusiness development. It broadly includes those arrangements under which producers commit to providing cash crop to a buyer firm. This paper exploits a panel dataset (2002–2005) collected by the Mozambican Ministry of Agriculture among a nationally representative sample of rural households to explore contracts' implications for gender equality both across and within households. We look at both the participation of female-headed households in contracts and the impact of establishing a contract on a set of intra-household women empowerment indicators. Concerning the first, our results confirm a (small though significant) effect of selection out of contracts of households where a woman is the household's head. With regard to the second, we expect contrasting effects to be at work: on the one hand, increased income may relax budget constraints improving women's living conditions, and on the other, we may expect a shift in favour of men of the control over the household's assets. We find different results according to the indicator used; after controlling for selection bias, we find no effect on control over land but a negative effect on women's access to extension services.
JEL Classification: O13, J16, C21, C23
Keywords: Contract farming, gender inequalities, women empowerment, Mozambique, propensity score matching

1. INTRODUCTION

This paper focuses on gender inequalities in access to markets and control of resources for agrarian production in rural Mozambique. For this purpose, we analyse contract farming arrangements, with respect to both gender-based inequalities in accessing them and to their impact on women's empowerment.

* Corresponding author: European Parliamentary Research Service, Square de Meeus 8, 1000 Brussels. E-mail: cecilia.navarra@gmail.com
† European Parliamentary Research Service

‡The author writes in her personal capacity. The content of the paper is the sole responsibility of the author and any opinions expressed herein should not be taken to represent an official position of the European Parliament.

doi: 10.1111/saje.12222

Contract farming is a form of vertical integration between agricultural producers and buyers (Oya, 2012). It comprises a range of contracts, whereby producers commit to supply cash crops to a buyer firm. They usually include timing and pricing arrangements and often set quality standards too (Smalley, 2013). According to the type of contract, firms may provide inputs and technical assistance to the producers.[1]

In the last 10 years, these arrangements have been considered a way in which agribusiness systems could benefit smallholders (World Bank, 2007). The Mozambican Plano Estratégico Para o Desenvolvimento do Sector Agrário (PEDSA) (RoM, 2011) considers them to be tools for market integration, allowing for a switch from subsistence production to commercial farming. Moreover, both Mozambican and international policy documents identify the potential for women empowerment in contract farming agreements. The PEDSA (RoM, 2011) makes reference to the Gender Strategy of the Agricultural Sector (2005), which has the strategic objective of "establishing partnerships between the public and private sectors to increase investment in support to small farmers and women in particular, sharing the costs and risks of assistance in adopting new technologies and new cash crops through programs aimed at food security and poverty reduction" (RoM 2005: 20).

Addressing gender-based inequalities in rural Mozambique is particularly relevant since there is abundant evidence that rural women play an important role in production but have little control over resources (Morgado and Salvucci, 2016; Arndt *et al*, 2011). This work attempts to address the issue from both intra-household and between-household perspectives. Concerning the latter, we adopt a consolidated approach; *i.e.* we compare female-headed households and male-headed households. There is a significant proportion of households headed by women in rural Mozambique (about 27% in 2005), but this share may have increased in the last decade (Morgado and Salvucci, 2016). We perform analysis to determine whether there is a systematic difference in access to contracts between female- and male-headed households. With reference to intra-household dynamics, the impact of being in a contract farming arrangement is analysed with respect to a number of indicators that capture women's access to assets for production and agrarian services. Methodologically, the main issue to address in order to analyse the consequences of being in such agreements, is the effect of selection into contracts. We cannot claim that evidence of a correlation indicates a causal effect because it is plausible that households that enter into contracts could differ significantly from households that do not.

Section 2 identifies the potential mechanisms through a brief literature review on contract farming and gender relations in rural households. Section 3 provides some background on rural Mozambique, describes the data used and presents descriptive statistics. Sections 4 and 5 develop the two main subjects of analysis in the paper: gender inequalities across households in terms of access to contract farming and gender inequalities within households, *i.e.* the impact of entering into contract farming on measures of women control over resources for agriculture. Section 6 discusses the results, and Section 7 concludes.

[1] Prowse (2012) underlines moreover that the contractual arrangement is non-transferable and gives the buying firm exclusive right on the crop.

2. CONCEPTUAL FRAMEWORK

The effect of increased commercial agriculture – in which contract farming may play a role – on gender inequalities is debated in both scholar and policy literature.[2] The main mechanisms that are at play, and that may have diverging impacts, are two. First, the increased income, which relaxes the budget constraints of the household, with possibly positive consequences on women's empowerment; second, a shift in towards men of the control over resources and income.

The debate about the need to close the gender gap in agriculture (FAO, 2011) has highlighted that value chain development can have a positive impact on rural women's empowerment if the private sector invests in value chains that integrate women and if governments "create a good investment climate through strengthening property rights" and customary land rights (Hill, 2011). Moreover, empirical analysis on the effects of contract farming, usually finds evidence of a positive income effect (Warning and Key, 2002, in Senegal; Bellemare, 2012, in Madagascar; Briones, 2015, in the Philippines).

At the same time, the literature analysing the impact of the shift towards commercial production highlights the risks of reducing output controlled by women and marginalising their labour. Women may face more difficulty accessing profitable markets since men might take over crop production from them once it becomes profitable (*e.g.* Njuki *et al.*, 2011). Some authors have argued that increased incentives to cultivate cash crops have increased women's workload (Evers and Walters, 2000) and the amount of income controlled by men (Warner and Campbell, 2000). Darity (1995) proposes a two-sector model in which men maximise income from the cash crop sector and women work in both the cash crop and subsistence sectors. An increase in cash crop prices implies that women are requested to spend extra time on work for the cash crop sector based on the assumption that their time devoted to reproductive work does not decrease. Evers and Walters (2000) introduce a bargaining framework and Warner and Campbell (2000) a duopoly model. In both papers, cash income is appropriated by men rather than women and, therefore, an increase in cash crop production compared to food crop production may result in an increase in the bargaining power of men within households.

These observations may apply to contract farming, too. The literature on contract farming highlights that the cost-reducing strategies employed by rural households to be competitive in value chains may entail substantial negative consequences for women (Key and Runsten, 1999) since the strategies may involve use of cheap or unpaid family labour. A study on Senegal (Maertens and Swinnen, 2012) underlined that women benefit more from vertical integration when they are workers rather than contract farmers. On the other hand, evidence of increased empowerment was found where women started demanding wages for previously unpaid tasks when they entered into formal value chains (*e.g.* in the case of tomato production in the Dominican Republic reported by Reynolds, 2002).

Most literature on Sub-Saharan Africa finds that women have historically been excluded from contractual arrangements with private investors due to their limited direct access to land and control over productive resources (Schneider and Gugerty, 2010),

[2] For an overview on contract farming in general, see *inter alia* Oya (2012), Prowse (2012), Smalley (2013).

especially by comparing the participation of male and female-headed households. The latter generally participate less in contract farming and get smaller increases in income from selling crops. In the Mozambican case, Boughton *et al.* (2007) find that female-headed households participate less in both tobacco and cotton growing schemes (after controlling for asset endowment). Benfica *et al.* (2012) do not find lower participation (when controlling for assets) but find lower revenues.

There is more broadly evidence that female-headed households have lower access to cash crop production both in and out of contracts. According to Evers and Walters (2000), this is due to a number of gender-specific constraints in access to markets: transport costs, security of property rights (especially those concerning land) and disruption of some ways to organise production that were favourable to women (*e.g.* cooperatives). In the Mozambican case, Daniel (2001) argues that women who are the head of their household lack access to the labour force and savings that are needed to begin cash crop production.

3. CONTEXT, DATA AND DESCRIPTIVE STATISTICS

This paper explores these research questions in the context of Mozambique, exploiting the panel dataset called Trabalho de Inqérito Agricola (TIA), which was collected by the Mozambican Ministry of Agriculture (MINAG) in collaboration with Michigan State University (MSU). The panel waves occur in 2002 and 2005, thus covering years with important growth of the Mozambican economy but limited poverty reduction, especially in rural areas (Cunguara and Hanlon, 2010).

The initial sample includes 4,908 household, but 804 could not be tracked in the second wave.[3] The balanced panel therefore has 4,104 households, for which we have data both in 2002 and 2005. The sample is exclusively rural and includes household who practice agriculture and/or grow cattle or poultry. In most of the analysis we will select households that possess land for agriculture, thus excluding those who only practice animal breeding (that will leave us in most of the cases with 4,039 observations).

The first aim of this paper is to analyse inequalities across households in terms of access to contract farming. Female-headed households comprise 22.9% of the TIA sample in 2002 and 26.7% in 2005. According to the National Statistical Institute, 36% of households were female-headed in 2011 (Morgado and Salvucci, 2016). They are, on average, poorer than other households (Arndt *et al.*, 2011) and have smaller plots and less access to inputs (FAO, 2005). There is evidence of a gender divide in agricultural productivity, where Morgado and Salvucci (2016) find a 20% gap in productivity between female- and male-headed households in the centre and north of Mozambique (but non-significant differences in the south). Because of the inverse relationship between size and productivity, female-headed households appear more productive, but this difference disappears when controlling for land size, as these households tend to have smaller plots. In their study, Morgado and Salvucci (2016) find that between 10% and 20% of the productivity gap is explained by factor endowment, while the rest is ascribed to other factors, including technical efficiency, pure discrimination and unobservable characteristics.

[3] An attrition rate of 17.3% can be considered relatively low in a rural setting (Mather *et al,* 2008).

The second purpose of this paper is to study within-household inequalities, paying special attention to gender differences in access to resources and services for production. In the Mozambican context, women have an important role in farming family plots, but they have lower access to markets (Boughton *et al.*, 2007). According to Arndt *et al.* (2011), women farmers allocate similar time to agrarian work as men but relatively more time on food crops than cash crops. In a study of Zambezia, De Brauw (2015) shows that women are less likely than men to manage the plots that they control, but there is no evidence that women manage lower-quality plots.

Especially for this second purpose, the panel dimension is crucial: we will be able to properly identify the effects of entering into contract farming arrangements in t_1 on selected outcomes, among households that were not into such arrangements in t_0. We will use propensity score matching to match households on the basis of pre-treatment variables ("pre-contract") to identify if there are different patterns whether the household enters or doesn't into a contract. Moreover, thanks to the longitudinal component of the data, we can properly identify movements "in" and "out" of contracts, thus comparing households that entered into such arrangements between the two waves and to households that did not.

The descriptive statistics of the TIA balanced panel (2002–2005) are displayed in Table 1.

The last column of the table provides the relevant information concerning the drop-outs of the balanced panel, *i.e.* the attrited households: it indicates if each variable displays a statistically significant difference in the attrited households with respect to the rest of 2002 dataset. Coherently with Mather *et al.* (2008), we find out that attrition seems to be informative, being differences significant on many dimensions, although these do not allow to identify a homogeneous group of drop-outs (on one hand, asset indicators – excluding size of landholdings – indicate that these may be poorer households with less access to the market; on the other hand, landholding and education go in the other direction). Interestingly, attrited households are more likely to be female-headed, to have a younger household head and to be bigger in size. These differences may partially explain some apparent changes in key variables between 2002 and 2005, especially the size of the household that seems to increase quite surprisingly between the two waves.[4]

Contract farming is especially relevant in the Mozambican cotton and tobacco sectors (which are concentrated in the centre and north of the country). Contract farming of these two main cash crops is based on a concession system: an exclusive sale agreement compels smallholders to sell to the company who holds the concession and, in principle,

[4] Table 1 shows that some important changes seem to occur between 2002 and 2005 in the balanced dataset. Some of them can be attributed to attrition bias, but this cannot explain all of them. The third column of the table indicates which differences are statistically significant. The decrease in the number of farmers engaged in cash crop production and in access to irrigation is somehow consistent with Mather *et al* (2008) that indicate that, contrary to what occurred in the late '90s, between 2002 and 2005 there has not been an increase in farmers' market participation in cash crop, nor of access to inputs. Still, we do not address in this paper the overall nature of the changes between the two waves and we try to minimise the bias that this can introduce in our analysis by systematically using explanatory variables at their baseline values.

Table 1. Descriptive statistics (standard deviation in parenthesis)

	2002	2005	Significant difference between waves	Significant difference of the "attrited" households
Income[1]				
Total income	9,220 (24,500)	10,760 (25,999)	***	No
Farm income	5,051 (11,423)	6,207 (16,970)	***	No
Non-farm income	4,106 (20,938)	4,517 (18,631)	No	No
Household characteristics				
Female-headed h	0.23 (0.42)	0.27 (0.44)	***	+***
Age h head	44 (15)	46.64 (14.89)	***	−***
Education of h head	2.78 (3.93)	3.12 (3.90)	***	+**
Size of h	5.76 (3.51)	7.18 (4.24)	***	−***
Assets				
Land (ha)	2.46 (5,54)	2.94 (4.20)	***	+***
Land (number of plots)	2.53 (1.39)	2.02 (1.18)	***	−**
Has non farm workers	0.23 (0.006)	0.35 (0.007)	***	No
Has lamp	0.55 (0.50)	0.50 (0.50)	***	−**
Has radio	0.54 (0.50)	0.56 (0.50)	*	−***
Has wc	0.42 (0.49)	0.46 (0.50)	***	−***
Has irrigation[2]	0.16 (0.37)	0.08 (0.27)	***	−***
Inputs				
Hires workers?	0.23 (0.42)	0.23 (0.42)	No	No
Uses animal traction	0.21 (0.41)	0.18 (0.38)	***	−***
Uses fertilizers	0.05 (0.22)	0.05 (0.22)	No	−**
Market participation				
Association member	0.05 (0.22)	0.09 (0.29)	***	−**
Received extension	0.15 (0.36)	0.19 (0.39)	***	−*
Received info prices	0.31 (0.46)	0.39 (0.49)	***	No
Cultivates cash crops	0.39 (0.49)	0.23 (0.42)	***	−**
Women empowerment measures				
At least one plot managed by a woman	0.50 (0.50)	0.44 (0.50)	***	No
Number of plots managed by a woman	1.06 (1.37)	0.82 (1.16)	***	No
At least one plot managed by a woman (incl. sales)	NA	0.11 (0.31)		NA
Number of plots managed by a woman (incl. sales)	NA	0.15 (0.49)		NA
Does a woman in the hh receive extension services?	NA	0.11 (0.31)		NA
Is a woman in the hh member of association?	0.034 (0.18)	0.053 (0.226)	***	No

Note: Balanced panel.

***p < 0.01, **p < 0.05, *p < 0.1.

[1]Constant 2002 prices.

[2]Including manual irrigation.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002–2005 (TIA) panel dataset.

requires that the company supports smallholders in the production process. It has to be noted that in Mozambique the structure of land ownership is characterised by very small landholdings. In the TIA 2002 sample, the median size of a plot of land is 1.5 ha.

First, we must identify which farmers participate in contract farming agreements. We know the main sale outlet for each cultivated crop, one of which is *companhia fomentadora* (the supporting company, which is how the buyer company is defined); a household is defined as "being into contract farming" if it has a supporting company as main outlet for at least one cultivated crop. In 2002, 254 households (6.2% of the sample) had a contract, and in 2005, 323 (7.9% of the sample). The most represented crops are indeed cotton and tobacco; 32% of cotton growers and 53% of tobacco growers have at least one contract farming arrangement with a company.

Households that are part of contract farming agreements significantly differ from households that are not. These differences are significant for an important set of variables (Table 2), especially asset endowment, access to inputs and access to services.

Table 2. Household characteristics for participants and non-participants in contract farming arrangements

	Non contract farming	Contract farming	Difference
Female-headed household	0.24	0.11	***
Age household head	44.42	43.28	
Education household head	2.75	3.17	
Size of the household	5.76	5.80	
Land size (ha)	2.38	3.75	***
Number of plots	2.49	3.15	***
Number of non-farm workers	0.24	0.13	**
Owns a lamp?	0.55	0.55	
Owns a radio?	0.54	0.69	***
Owns a wc?	0.41	0.56	***
Has irrigation (at least on one plot)?	0.15	0.25	***
Hires workers?	0.21	0.44	***
Uses animal traction?	0.21	0.25	
Uses fertilizers?	0.03	0.34	***
Is association member?	0.05	0.11	***
Receives extension services?	0.14	0.30	***
Received information on prices?	0.30	0.46	***
Produces cash crops?	0.37	0.85	***
N	3850	254	

Note: Data at baseline (2002). Balanced panel.

***p < 0.01, **p < 0.05, *p < 0.1.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002–2005 (TIA) panel dataset.

4. FEMALE-HEADED HOUSEHOLDS AND SELECTION INTO (AND OUT OF) CONTRACTS

The first part of our analysis focuses on inequalities across female- and male-headed households. Female-headed households comprise 23% of the sample in 2002 and 27% in 2005.

There is evidence of a negative correlation between female-headed households and participation in contracts (Table 3). At the baseline, 7.1% of male-headed households are in contract farming arrangements, as opposed to only 2.9% of female-headed households.

Of course, female- and male-headed households have a number of differences that may explain their differential access to contract farming. Table 3 shows these differences at the baseline: on average, female-headed households are smaller, the head of household is 1 year older and has less education compared to male-headed households. A woman who is the head of her household is much more likely to be divorced or widowed (65% compared to 3% of men). Female-headed households also have smaller and fewer plots, although they are more dependent on agriculture (the household head practices farming as main activity in 96% of cases, while this proportion decreases to 79% in the case of men). In addition, female-headed households are poorer in terms of both income and assets.

These characteristics, which may be themselves the result of unequal distribution of resources and entitlements, may explain female-headed households' more limited access to contract farming arrangements. These households have significantly less access to extension services and inputs, such as fertilizers and less ability to hire workers, which may be crucial to access contracts.

Table 3. Household characteristics for male and female-headed households

	Male-headed	Female-headed	Difference
Is into a contract farming agreement?	0.071 (0.005)	0.029 (0.005)	***
Age household head	43.9 (0.26)	45.7 (0.49)	***
Household head has some formal education?	0.64 (0.008)	0.27 (0.14)	***
Size of the household	6.16 (0.65)	4.43 (0.087)	***
Hh widowed or divorced	0.03 (0.003)	0.65 (0.02)	***
Number of hh members not in working age	3.01 (0.04)	2.20 (0.06)	***
Number of men in working age	1.52 (0.19)	0.78 (0.031)	***
Number of women in working age	1.64 (0.023)	1.45 (0.03)	***
Hh main activity agriculture	0.79 (0.007)	0.95 (0.007)	***
Land size (ha)	2.72 (0.11)	1.59 (0.086)	***
Number of plots	2.61 (0.25)	2.24 (0.41)	***
Number of non-farm workers in the hh	0.34 (0.012)	0.22 (0.018)	***
Total household income	10,692 (488)	4,282 (242)	***
Owns a lamp?	0.58 (0.008)	0.43 (0.02)	***
Owns a radio?	0.61 (0.008)	0.32 (0.015)	***
Owns a wc?	0.44 (0.008)	0.37 (0.15)	***
Has irrigation (at least on one plot)?	0.16 (0.006)	0.16 (0.012)	
Hires workers?	0.256 (0.008)	0.13 (0.011)	***
Uses animal traction?	0.22 (0.007)	0.18 (0.01)	***
Uses fertilizers?	0.06 (0.004)	0.029 (0.005)	***
Is association member?	0.054 (0.004)	0.046 (0.007)	
Receives extension services?	0.162 (0.007)	0.105 (0.01)	***
Received information on prices?	0.33 (0.008)	0.22 (0.13)	***
Produces cash crops?			
N	3161	943	

Note: Data at baseline (2002).

***p < 0.01, **p < 0.05, *p < 0.1.

The income and land dimensions are captured by Figs. 1 and 2.

In a comparison of participation in contract farming across both land and income quartiles, nevertheless, we still find significant gender-related differences (Table 4); female-headed households are characterised by less participation in contracts in all land quartiles[5] and in the first three income quartiles. Only in the richer quartile does this difference disappear.

Next, let us consider a multivariate framework and examine the determinants of participation in contract farming in 2005. We use the balanced panel dataset and further exclude households that do not have a plot of land for agricultural purposes (meaning that they only practice animal breeding but not agriculture). We then perform a probit model using inverse probability weights to account for attrition bias[6] (as suggested by Mather *et al*, 2008 and Giesbert and Schindler, 2012). The unconditional marginal effect is –0.065, meaning that a female-headed household has a probability of being in a contract farming arrangement that is 6.5 percentage points lower if compared to a male-headed household. This difference may include of course the effect of major confounding factors. We then control for lagged asset endowment (land, fixed assets, land title, irrigation, etc.), lagged access to services (extension, association) and lagged access to inputs (hiring workers, use of fertilisers and pesticides). The characteristics of the household, including the dummy variable capturing the gender of the head of household, are contemporary to the dependent variable.[7]

[5] We apply the same exclusion of outliers as in the previous graphs.

[6] We follow Baulch and Quisumbing (2011).

[7] We made this choice because we do not expect reverse causality between contract farming and household (and head of household) characteristics. The results are robust when these are replaced with lagged controls.

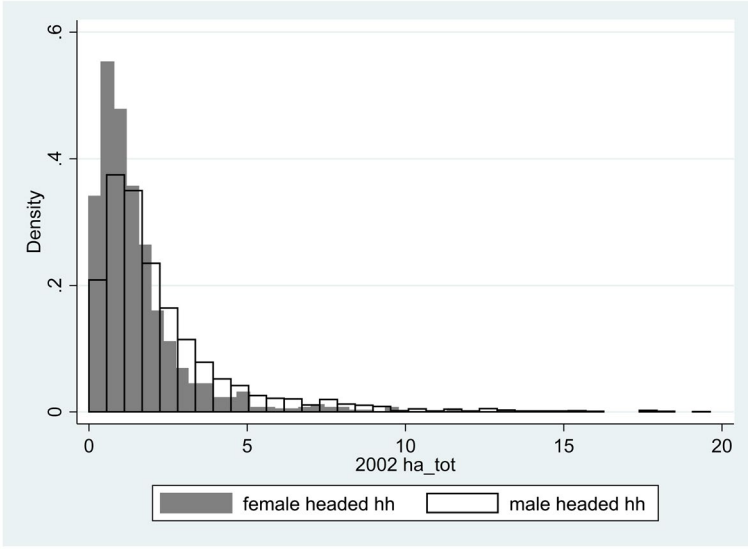


Figure 1. Land size in 2002 (baseline) [We exclude observation with more than 20 ha.] [Colour figure can be viewed at wileyonlinelibrary.com]
Source: Author's illustration based on the Trabalho de Inquérito Agricola 2002–2005 panel dataset.

Table 5 shows the marginal effects computed using the probit model.[8] In Column 1, only household characteristics and main income and food production measures are included as controls. Column 2 includes variables to capture asset endowment, and Column 3 includes variables measuring access to input and services. The age of the household head and the size of the household seem to be consistently significant across different specifications. The former negatively affects the probability of being in a contract, while the second positively affects it. Food own production (tons per capita) and the dummy variable indicating whether the household was already producing cash crops in 2002[9] both significantly affect the probability of having a contract in 2005. Assets have different effects, and interestingly, the number of plots seems to have a greater impact than the size of landholdings. Among inputs, access to pesticides seems to be most important.

Female-headed households have a significantly lower probability of entering into contract farming across all specifications, although the impact decreases from about −0.065 (unconditional difference not shown) to −0.035 after controlling for asset endowment and access to inputs. In Column 4, we control for a dummy that indicates whether the

[8] The size of the sample is reduced because of the introduction of province (Columns 1–5) and district fixed effects. In the first five columns, we have to exclude the observations (652) that are in provinces in which no contract farming is observed (the southern provinces of Maputo and Inhambane). Similarly, in the last specifications, all observations in districts in which no contract farming occurs are dropped, leading to a much smaller sample (about 1900 observations).

[9] Producing cash crops and being in a contract are correlated since most contracts are established for cash crops but do not completely overlap. The results remain the same if we do not control for lagged cash crop production.

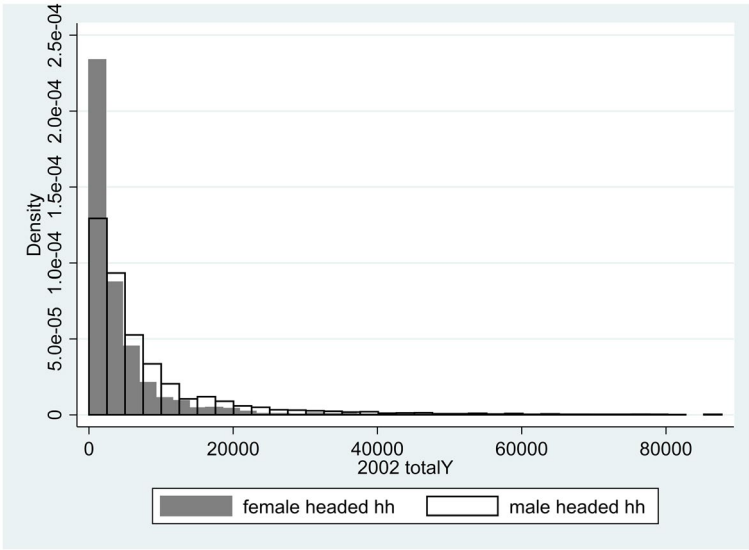


Figure 2. Total income in 2002 (baseline) [We exclude the top 1% of observations.] [Colour figure can be viewed at wileyonlinelibrary.com]
Source: Author's illustration based on the Trabalho de Inquérito Agricola 2002–2005 panel dataset.

head of household is widowed or single. Although this is not significant, it decreases the impact of the gender of the head of household by 0.7% point (that moreover becomes significant only at the 10% level). In Column 5, the size of the household is replaced by the number of men of working age to account for the differential composition of male- and female-headed households, which can reflect the differential availability of the labour force. This further decreases, albeit marginally, the effect of head of household to −0.027. The last specification (Column 6) includes district-level fixed effects. Interestingly, this increases the differences caused by the gender of the head of household. Within the same district, the marginal effect of having a woman as household head on the probability of being in contract farming agreement is −0.052.[10]

We do not use a panel specification as main one because there is little variation over time both of contract farming and of the gender of the household head (and, when it does, it is likely to be due to major confounding effects, such as migration or a death in the family that may themselves strongly impact the probability of being into contracts). Still, Table 6 presents the results of a probit random effect model[11] in which the dependent variable takes value 1 if the household is engaged in contract farming.

The coefficient of the gender of the household head is still weakly negative and significant, but, for the reason indicated before, we do not consider this as the most

[10] The results presented are also robust if controlling for a dummy variable that captures participation in contract farming in 2002.

[11] We use a random effect model because there is too little variation in contract farming between t_0 and t_1.

Table 4. Differences in participation in contract farming between male- and female-headed households across land and income quartiles (standard deviations in parenthesis)

	Share of male-headed households in contract farming	Share of female-headed households in contract farming	Difference
Total			
Quartiles of land size			
I	0.022 (0.006)	0.009 (0.005)	*
II	0.059 (0.009)	0.027 (0.010)	**
III	0.086 (0.010)	0.053 (0.015)	*
IV	0.108 (0.010)	0.049 (0.020)	**
Quartiles of total income			
I	0.021 (0.006)	0.008 (0.004)	**
II	0.046 (0.008)	0.016 (0.008)	**
III	0.075 (0.009)	0.038 (0.014)	**
IV	0.129 (0.011)	0.110 (0.029)	

Notes: Data at baseline: Differences are bigger in 2005 (not shown).

***p < 0.01, **p < 0.05, *p < 0.1.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002–2005 (TIA) panel dataset.

appropriate way to investigate the effect of being a female-headed household on contracts. Income moves in the same direction as participation in contract farming. Variables indicating access to inputs appear to play a major role, and assets play much less of a role (but again, these are variables that do not change substantially over time). Cultivating cash crops and having the household head directly engaged in agriculture are closely related to the probability of being into contract farming arrangements.[12]

4.1 Robustness Checks

As a robustness check, we use propensity score matching to compare female- and male-headed households at t_1. We consider a female head of household to be the "treatment variable," and we compare households that are similar in a number of different variables but differ with respect to the gender of the head of household. We use the predicted values of a probit model to identify the closest male-headed household to each female-headed household (*i.e.* the most similar based on the observable variables[13]). These observables are measures of asset endowment, income and production, access to inputs and services and basic household characteristics.[14]

As shown in Table 7, if we do not control for the household head being divorced or widowed, we find a smaller but still negative effect going in the same direction of our main specification, thus confirming that female-headed households have lower probability to enter into contract farming arrangements. If we control for the marital status of the household head, the effect is not significantly different from zero, meaning that if we compare

[12] In this specification, endogeneity bias may have a relevant impact, so we have to be particularly careful in inferring causality.

[13] As mentioned later, the main limitation of propensity score matching is that observations are matched only on the basis of observable characteristics. Thus, this does not allow one to identify all differences related to non-observable characteristics.

[14] The treatment effects are calculated with a one-to-one match, and the Abadie-Imbens (Abadie and Imbens, 2016) standard error is estimated.

Table 5. Determinants of the probability of being in a contract farming agreement in 2005. Marginal effects after Probit

	(1)	(2)	(3)	(4)	(5)	(6)
Female-headed household 2005	−0.0411***	−0.0409***	−0.0347***	−0.0281*	−0.0276*	−0.0524**
	(0.0142)	(0.0147)	(0.0134)	(0.0148)	(0.0147)	(0.0263)
Log of total income 2002	0.0103	0.00985	0.00482	0.00478	0.00559	−0.000372
	(0.00735)	(0.00866)	(0.00911)	(0.00914)	(0.00906)	(0.0143)
Age of head of household 2005	−0.00115***	−0.00135***	−0.00140***	−0.00134***	−0.00129***	−0.00215***
	(0.000336)	(0.000347)	(0.000342)	(0.000375)	(0.000386)	(0.000615)
Household head education 1 2005	−0.0135	−0.0142	−0.0145	−0.0144	−0.0129	−0.0146
	(0.0145)	(0.0143)	(0.0148)	(0.0149)	(0.0149)	(0.0225)
Household head education 2 2005	−0.0235	−0.0238	−0.0232	−0.0227	−0.0214	−0.0288
	(0.0201)	(0.0204)	(0.0206)	(0.0206)	(0.0206)	(0.0326)
Household head education 3 2005	−0.0559*	−0.0451	−0.0384	−0.0377	−0.0358	−0.0488
	(0.0327)	(0.0340)	(0.0319)	(0.0319)	(0.0320)	(0.0516)
Cultivates cash crops? 2002	0.129***	0.116***	0.0866***	0.0862***	0.0861***	0.105***
	(0.0226)	(0.0208)	(0.0161)	(0.0161)	(0.0161)	(0.0220)
Size of the household 2005	0.00286*	0.00220	0.00234	0.00223		0.00257
	(0.00151)	(0.00158)	(0.00152)	(0.00152)		(0.00290)
Number of men in working age in hh 2005					0.00222	
					(0.00474)	
Food production per capita (ton) 2002	0.0356***	0.0287**	0.0297**	0.0295**	0.0254**	0.0400*
	(0.0130)	(0.0116)	(0.0119)	(0.0119)	(0.0115)	(0.0205)
Owns a lamp? 2002		−0.0271*	−0.0282**	−0.0284**	−0.0282**	−0.0392*
		(0.0140)	(0.0127)	(0.0126)	(0.0126)	(0.0204)
Owns a radio? 2002		−0.000924	0.00158	0.00126	0.00175	0.0156
		(0.0104)	(0.0103)	(0.0103)	(0.0103)	(0.0164)
Owns a wc? 2002		0.0218*	0.0180*	0.0173	0.0171	0.0139
		(0.0112)	(0.0107)	(0.0106)	(0.0105)	(0.0195)
Owns a granary? 2005[1]		0.0191	0.0220*	0.0216*	0.0216*	0.0305
		(0.0138)	(0.0129)	(0.0130)	(0.0130)	(0.0203)
Has irrigation (at least on one plot)? 2002		−0.0175	−0.0313**	−0.0313**	−0.0316**	−0.0536**
		(0.0149)	(0.0144)	(0.0145)	(0.0145)	(0.0255)
Has at least one titled plot? 2002		0.000102	0.00746	0.00864	0.00765	0.0164
		(0.0417)	(0.0401)	(0.0403)	(0.0403)	(0.0750)
At least one hh member is waged worker 2002		−0.0388**	−0.0357*	−0.0355*	−0.0357*	−0.0289
		(0.0178)	(0.0187)	(0.0187)	(0.0188)	(0.0309)
Size of landholding (ha) 2002		0.000955	−4.79e-05	−5.75e−05	0.000277	0.00382
		(0.00129)	(0.00139)	(0.00140)	(0.00129)	(0.00264)
Number of plots 2002		0.0113**	0.00659	0.00652	0.00690	0.00622
		(0.00480)	(0.00441)	(0.00441)	(0.00437)	(0.00619)
Hires workers? 2002			0.00423	0.00460	0.00472	−0.00619
			(0.0143)	(0.0145)	(0.0148)	(0.0217)
Uses animal traction? 2002			0.0117	0.0114	0.0119	0.0186
			(0.0198)	(0.0198)	(0.0204)	(0.0323)
Uses fertilizers? 2002			0.0457**	0.0461**	0.0453**	0.0306
			(0.0188)	(0.0188)	(0.0187)	(0.0288)
Uses pesticides? 2002			0.0868***	0.0874***	0.0878***	0.0822***
			(0.0191)	(0.0190)	(0.0190)	(0.0274)
Received extension services? 2002			0.0126	0.0126	0.0124	0.0259
			(0.0136)	(0.0136)	(0.0136)	(0.0195)
Member of association? 2002			0.00783	0.00792	0.00821	0.000784
			(0.0295)	(0.0297)	(0.0297)	(0.0476)
Hh head is widowed or divorced 2005				−0.0184	−0.0199	−0.0197
				(0.0214)	(0.0218)	(0.0341)
PROV FE	YES	YES	YES	YES	YES	NO
	NO	NO	NO	NO	NO	YES
Observations	3,355	3,355	3,355	3,355	3,355	1,908

Note: Standard errors in parentheses.

[1]We don't have the information whether the households owned a granary at baseline.

***p < 0.01, **p < 0.05, *p < 0.1.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002-2005 (TIA) panel dataset.

Table 6. Probit Panel Random effect model Y = 1 if household is in contract farming

	(1) Merginal Effects
Log of total income	0.271***
	(0.0444)
Female-headed household	−0.179*
	(0.0993)
Age of household age	−0.00274
	(0.00275)
Size of the household	−0.00494
	(0.0118)
Household head education 1	−0.0122
	(0.0800)
Household head education 2	0.0454
	(0.130)
Household head education 3	−0.264
	(0.190)
Size of landholding (ha)	−0.00693
	(0.00769)
Number of plots	−0.0224
	(0.0353)
Owns a lamp? 2002	−0.0649
	(0.0766)
Owns a radio? 2002	0.0189
	(0.0669)
Owns a wc? 2002	−0.0577
	(0.0827)
Has at least one titled plot?	−0.0718
	(0.168)
Hires workers?	−0.0688
	(0.0798)
Uses animal traction?	−0.0239
	(0.151)
Uses fertilizers?	0.831***
	(0.216)
Uses pesticides?	1.115***
	(0.155)
Received extension services?	0.139*
	(0.0822)
Member of association?	−0.0462
	(0.115)
At least one hh member is waged worker	−0.0608
	(0.0937)
Food production per capita (ton)	0.108
	(0.101)
Cultivate cash crops?	1.386***
	(0.179)
Receive remittances?	−0.134
	(0.0838)
Is agriculture the main activity of the household's head?	0.363***
	(0.106)
Constant	−5.095***
	(0.551)
Observations	8,790
Number of id	4,872

Note: Robust standard errors in parentheses.

***p < 0.01, **p < 0.05. *p < 0.1.

two households that differ for the gender of the household head, but he or she is divorced (widow) in both cases, we do not find any difference in the access to contract farming. The problem with this specification is that the great majority of divorced and widowed household heads are women, thus it is difficult to properly disentangle the two effects, as we will discuss further on.

Table 7. ATT of "being a female-headed household" on the probability of being into contract farming in 2005, after matching

	(1)	(2)
Female-headed household in 2005	−0.0218**	−0.00664
	(0.00993)	(0.0110)
Observations	3,974	3,974

Note: Standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1.

Moreover, it has to be noted that this estimation has to be taken with a grain of salt because we are implicitly assuming that the variables used to construct the propensity scores are not affected by the treatment variable, *i.e.* the gender of the husehold head. This assumption is easily violated in our setting. Despite the limitations of this specification, the message that it gives is to be careful to interpret our results as causal, since we cannot rule out possible endogeneity biases.

5. IMPACT OF CONTRACT FARMING ON WITHIN-HOUSEHOLD GENDER INEQUALITIES

The aim of this paper is also to introduce intra-household measures of women empowerment and gender inequalities. We focus on measures of empowerment that are related to agrarian production. This, of course, excludes several other possible measures. This choice is due both to data availability and to the effects of contract farming that we want to test.

We look at two measures of women empowerment in farming activities, each captured by two variables:

A Women's control over assets
1. A dummy variable indicating if at least one plot is under the responsibility of a woman both for production and sales;
2. The change in the number of plots which under the responsibility of a woman for what concerns production.[15]

B Women's access to agrarian services
1. A dummy variable indicating whether at least one women in the household is member of an association (conditional upon the fact that the household has at least one member)
2. A dummy variable indicating whether at least one women receives extension services (conditional upon the fact that the household is receiving extension services)

The first set of variables are similar to those used by de Brauw (2015). Whereas he uses information indicating control over plots and the identity of the person deciding which crop to grow, we use information indicating whether a woman is responsible for production on a plot and whether she is responsible for production and sales. This is

[15] Unfortunately, the data does not allow us to calculate the same variable for plots for which a woman is responsible for both production and sales.

Table 8. Women empowerment measures in households with or without contract farming agreements

	Contract farming	Non contract farming	Difference
At least one plot is under women's responsibility both for production and sale (2005)	0.13	0.11	
Change in the number of plots under the responsibility of a woman for production	−0.08	−0.25	**
Woman is member of association (2005) (if the household is)	0.29	0.63	***
Woman receives extension services (2005) (if the household does)	0.49	0.62	**

***p < 0.01 **p < 0.05, *p < 0.1.

relevant since women may be responsible for a plot but not managing the income it produces (Navarra and Pellizzoli, 2012). In 2005 (the only year for which we have both types of information), 44% of the households had at least one plot for which a woman was responsible, but only 11% had a plot for which the woman was responsible for both production and sales.

If we look at descriptive statistics (Table 8), we observe that measures of women's access to assets show a null or positive correlation with contract farming. Additionally, the number of plots managed by a woman are decreasing on average but decreasing less in households that are engaged in contract farming. On the contrary, measures of access to services (both extension and association membership) are significantly lower for women in households that have a contract farming arrangement.

To avoid selection bias, we use propensity score matching,[16] considering participation in contract farming to be the "treatment." This means that – among households that are not under a contract – we identify a group that is comparable with households that are under a contract; "comparable" means having a number of similar characteristics measured at baseline.

To do so, we use the predicted values of a probit model in which the dependent variable is the probability of contract farming given a set of pre-treatment characteristics to identify the "closest" non-contract farming observation. These predicted probabilities define the propensity score. This allows us to identify two groups that have the same probability of being treated conditional upon a set of observables, which include measures of income, food production, asset endowment, access to inputs, and a vector of household characteristics, all of which are measured at the baseline (2002).[17]

After matching, we compute the average treatment effect on the treated, *i.e.* the conditional impact of engagement in contract farming on our outcome variables. When possible, we exploit the variation in the outcome variable at two points in time (this is possible only for variable A2) and we thus perform a quasi-difference-in-difference estimation with matching. This is the only case where we can consider the identification strategy to

[16] Inter alia, Ravallion (2007). Evaluating anti-poverty programs. *Handbook of development economics*, *4*, 3787–3846.

[17] The probit model used to estimate the propensity score and the plot of the propensity scores is in the Appendix.

properly account for endogeneity, while in the other cases (variables A1, B1 and B2) the data do not allow us to exploit a variation in time. We will run some robustness checks to support the main result.

In order to consider contract farming a "treatment," we have to appropriately select our sample. The starting point is the balanced panel, where only households with farmed land are considered (4,039 observations). By exploiting the panel nature of the data, we can observe movements in and out of contracts. This allows us to identify four subgroups: those who never enter into contract farming (N = 3,557), those who are always in a contract (at both points in time; N = 91), those who were in a contract in 2002 but not in 2005 (N = 159) and those who were not in a contract in 2002 but were in 2005 (N = 232; for more detailed description of the four groups, see Navarra, 2017).

Our analysis is restricted to groups 1 and 4; thus, we exclude the households that were under a contract at the baseline (*i.e.* in 2002). This allows us to compare, among the households that were not under a contract in 2002, those who entered into a contract farming agreement and those who did not. The sample size is therefore reduced to 3789 observations.

We further restrict our sample to those households with both a man and woman of working age in order to be sure that a possible shift of control over production activity may actually occur. This means dropping 576 observations and further reducing our sample to 3213 observations.

The four dependent variables are therefore:

(A1) y = Is at least one plot under a women's responsibility in terms of both production and sales (dummy in 2005)?
(A2) $y = (\text{Nplots}_{T,2005} - \text{Nplots}_{TT,2002}) - (\text{Nplots}_{C,2005} - \text{Nplots}_{C,2002})$.
(B1) y = Does a woman receive extension services, conditional upon the household receiving an extension (dummy in 2005)?
(B2) y = Is a woman a member of an association, conditional upon the household having at least one member (dummy in 2005)?

In specifications 1, 2 and 3, the matching equation includes province-fixed effects,[18] while in specification 4, this is not the case due to a lack of observations. The two last columns display much lower sample sizes because we have isolated the sample of households receiving extension services (col. 3) and the sample of households that are members of a producers' association (col. 4).

Table 9 displays the average treatment effect on the treated (ATT) for the outcome variables mentioned above. Here, "treatment" refers to being in an contract farming agreement in t_1 (2005). The ATT is expressed as follows:

$$ATT = E\left(y_1 - y_0 \mid t = 1\right)$$

[18] This means that we had to drop the provinces in which no contract farming is observed (two southern provinces, Maputo and Inhambane). This reduces the sample to 2692 observations.

Table 9. ATT of "being in contract farming" 2005, after matching

	(1) At least one plot is under the responsibility of a woman also for selling (2005)	(2) Change in the number of plots managed by a woman (2005–2002)	(3) A woman receives extension services (2005)	(4) A woman is part of a producers association[1] (2005)
Contract farming in 2005	−0.00463	−0.00926	−0.128*	−0.0370
	(0.0293)	(0.121)	(0.0659)	(0.139)
Observations	2,692	2,686	541	302

Note: Standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1.

[1]Does not control for province fixed effects.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002–2005 (TIA) panel dataset.

The treatment effects are calculated with a one-to-one match,[19] and the Abadie-Imbens (Abadie and Imbens, 2016) standard error is calculated in order to take into account the fact that propensity scores are estimated. The probit model used to estimate propensity scores and a graph displaying the balance of the covariates are in the Appendix.[20]

The effect of contracts on control over land – which displayed positive or no correlation in the descriptive statistics – is not significantly different from zero. We cannot therefore claim a causality link between contract farming and women's control over land. On the other hand, we find that entering into contract farming has a significant and negative effect on the probability that, if the household receives extension services, these services are addressed to a woman within the household. The coefficient of the probability that women are members of producers' associations is negative but not significantly different from zero.

5.1. Robustness Checks

As a robustness check, we ran the same analysis but excluding female-headed households (see Table 10). The impact on access to extension services disappears, but the effect on access to producers' associations becomes significant. The result goes in the same direction as before but signals potential variability according to the sample used. We did not expect the result to hold true only for male-headed households since, if control of resources shifts away from women, it may shift towards male household members other than the husband (*i.e.* an adult son or other male relative). Notably, in the main specification (Table 9) we restricted the sample to households with at least one man and woman of working age.

Concerning attrition bias, as suggested by Leuven and Sianesi (2003), instead of using weights in the matching model, we perform the same analysis using a logit model and matching on the logarithm of the odds ratio of the propensity score.[21] We find a little

[19] The results are robust to more neighbours matched (up to five) and to a Kernel matching model.

[20] In this specification we do not use weights for attrition (see robustness checks)

[21] Here we use the Stata psmatch2 command.

Table 10. ATT of "being in contract farming" 2005, after matching, excluding female headed households

	(1) At least one plot is under the responsibility of a woman also for selling (2005)	(2) Change in the number of plots managed by a woman (2005–2002)	(3) A woman receives extension services (2005)	(4) A woman is part of a producers association (2005)
Contract farming in 2005	−0.0203	−0.0457	−0.0833	−0.240***
	(0.0288)	(0.104)	(0.109)	(0.0876)
Observations	2,163	2,157	454	241

Note: Standard errors in parentheses.

***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

stronger negative effect, although significant only at 10% level, going in the same direction as in Table 9 (see Table 11).

A common critique of propensity score-matching techniques is that they only allow for selection on observables. As a robustness check, we use Abadie semi-parametric difference-in-difference (Abadie, 2005; Houngbedji, 2016), which uses a reweighting technique to address the imbalance of characteristics between the treatment and control group to make the assumption of parallel trends in the outcome variables between the two groups more credible. We focus only on the outcome variable for which we know the variation over time, *i.e.* the change in the number of plots for which a woman is responsible in the production phase. The previous result holds true; again, the effect is positive but not significantly different from zero (see Table 12).

6. DISCUSSION

This work is divided into two parts. The first analyses gendered differences in access to contract farming agreements, and the second analyses the impact of contract farming on measures of within-household women empowerment in farming activities.

In the first part, we find that female-headed households have a lower probability of entering into contract farming arrangements. This difference decreases from 6.5 percentage points in the unconditional model, to 3.5 after controlling for education, assets, access to inputs, and some characteristics of the household and of the households head. This is a relatively small, but statistically significant difference.

The magnitude of the negative coefficient of female headed households is further reduced when controlling for the household head being divorced or widowed, that indicates that part of the negative effect can be due to a traumatic family event affecting other dimensions (*e.g.* social capital) other than the identity of the household head. This variable captures all the effect when we turn to propensity score matching, aiming at comparing households that only differ for the identity of the household head. We have two main caveats in this respect. First, the gender of the household head and the marital status are highly correlated: 65% of women household head are widowed or divorced, while only 3% of men are. Second, by performing a matching model between female- and male-headed households we are implicitly assuming that the variables used to construct the propensity scores are not affected by the identity of the household head. This assumption is clearly problematic in our setting. Therefore, we do not consider that the

Table 11. ATT of "being in contract farming" 2005, after matching, Logit model, matching on odds of propensity scores

	(1) At least one plot is under the responsibility of a woman also for selling (2005)	(2) Change in the number of plots managed by a woman (2005–2002)	(3) A woman receives extension services (2005)	(4) A woman is part of a producers association (2005)
Contract farming in 2005	−0.0231	−0.130	−0.167*	−0.0741
	(0.0427)	(0.148)	(0.0934)	(0.164)
Observations	2,713	2,686	544	138

Note: Standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1.

Table 12. Abadie semi-parametric DID

	Difference in the number of plots controlled by a woman
Contract farming in 2005	0.0832
	(0.0723)
Observations	2,183

Notes: Standard errors in parentheses.

***p < 0.01, **p < 0.05, *p < 0.1.

Source: Author's calculations based on the Trabalho de Inquérito Agricola 2002–2005 (TIA) panel dataset.

robustness check puts strongly into question the result displayed in Table 5. Still, it indicates that it should be taken cautiously when trying to infer causality.

This result indicates that there may be some "residual" discrimination effect against female-headed households in access to contract farming (cfr. Morgado and Salvucci, 2016). This is nevertheless relatively small in size and could be further analysed in order to identify if it captures other factors. It must be noted that this result does not change after controlling for productivity,[22] measured by food production per hectare, which rules out the possibility that exclusion from contract farming depends on the lower productivity of plots managed by women.

This result is consistent with the qualitative evidence discussed by Navarra and Pellizzoli (2012): in the absence of specific actions devoted to inclusion of women, women farmers risk being excluded from contract farming agreements. This is not related to women's apparent disconnection from the market; women participate in market activities and have livelihood strategies that include crop marketing, although they may display greater attention to food production and have access to more limited markets than men. Although there is evidence of a productivity gap (Morgado and Salvucci, 2016), Navarra and Pellizzoli (2012) do not find that this is a major determinant of exclusion from contracts. In fact, in their qualitative analysis, they report interviews in which private investors define women as "excellent farmers." The women farmers interviewed consider education, illiteracy and access to information to be major problems.

The second part of the paper focuses on the impact of contract farming on some indicators of women empowerment within households. Before controlling for selection,

[22] This result is not shown for the sake of readability of the table.

we find a positive or null correlation between contract farming and women's control over the production and sales of crops but a negative correlation with women's membership in an association and access to extension services. After controlling for selection, the only robust result is the negative impact on the probability that women will receive extension services (conditional upon the households' receipt of such services). In the literature, we find elements pointing at positive and negative effects of contract farming on women's control over assets and access to services. In most indicators used here, the effects seem to cancel out, but in the case of access to extension services, the negative effects seem to prevail. This aligns with the observation that contracts are usually in the man's name (Navarra and Pellizzoli, 2012), which implies that all services provided to households in the framework of a contract are channelled towards men.

This is a narrow measure of empowerment, since it just captures control over farming activities, while it doesn't say anything about non-farm activities or on non-economic measures of empowerment. One could even argue that receiving extension services is not empowering per se. Still, even if we assume that providing extension services to any member of the household produces knowledge spill-over to all active members, it is likely that the identity of the recipient matters. There are reasons to think that extension could be empowering: it may define *who* is knowledgeable about a specific crop or technique in the household, thus establishing effects of social recognition and providing social capital, connections and mobility opportunities.

Limitations must be pointed out as the result is sensitive to the sample used, and especially if female-headed households are excluded (access to extension services is not significantly impacted, but access to an association does). We do not expect female-headed households to behave differently, as long they have both men and women in working age, since we may expect a shift in control over resources to male members of the household other than the husband. The results still have the same direction, but the differences found indicate their potential lack of robustness. A stronger limiting factor is that our main result (impact on access to extension services) is found on a small sample (541 observations), since we only observe the cases where extension is actually delivered to households. This has to be taken into account and the result interpreted with caution.

Concerning access to land, the correlation – where it exists – is ascribed to selection: households in which women acquire greater control over farming land (or, more precisely, where they lose less control) are more likely to enter into contracts. This should be further explored in future work. The fact that contract farming does not produce significant effects on control over resources is consistent with its limited impact on the structure of households' production. Overall, it seems that the patterns of production do not shift substantially; households entering into contracts do not abandon food production, and cash crops are a complement rather than a substitute for production of staple crops (Navarra, 2017).

7. CONCLUSIONS

In this paper, we analyse gender inequalities across and within households in rural Mozambique. We focus especially on gender inequalities in access to contact farming and on its effects on women empowerment in rural households.

In the first part, we observe households that enter into contracts and find systematic evidence of a negative, albeit small, effect associated with female-headed households. This is globally consistent with the existing literature but still needs further analysis since the result is robust to several controls, including asset endowment, access to inputs, market access and productivity measures. It seems weakened when controlling for the marital status of the household head (whether widowed or divorced); especially if we match female- and male-headed households with propensity score matching, including marital status in the matching equation leads to a negative but non-significant coefficient for the gender of the household head. This is difficult to interpret since the overlapping of this characteristic with the gender of the household head is significant, but indicates that we should not interpret the result as causal.

The "residual" negative probability for female-headed households to enter into contracts – 3.5 percentage points, or 2.7 percentage points after controlling for the marital status – shall be further explored and may relate to stereotypes regarding gender roles, social capital and information network measures, or to other channels of discrimination. Since there is evidence that contract farming has a positive impact on income (Navarra, 2017), this selection pattern indicates that contracts may increase gender inequality across households.

The main contribution of this paper is that it complements this approach with an analysis of gender inequalities within households. We focus on indicators measuring women empowerment with respect to control of assets and access to services and, thus, on women's role as farmers. We are aware that this is a non-exhaustive measure of empowerment since it does not capture off-farm work, bargaining power, reproductive health, etc. Several other indicators may be used. The reason for selecting these ones is that our main predictions derived from the literature focused on control over resources and access to services for agriculture. In the descriptive statistics, we observe a positive or null correlation between contract farming and women's control over land, and a negative correlation between contract farming and access to services (extension and producers' associations). After controlling for selection bias, the positive effect on control over resources disappears, as does the negative effect on participation in producers' associations. Contracts still have a negative impact on the probability that women receive extension services when their household does. This can increase inequality since extension services can be a source of empowerment and relative bargaining power within the household. As we pointed out in the previous section, this result is subject to a number of caveats concerning sample size, since it is obtained on a much smaller sample that the overall database, and it is sensitive to the exclusion of female-headed households. Still, as we illustrated, we argue that the main result can be reasonably considered to hold, even if we shall be cautious in drawing causal inference.

Besides what discussed regarding the identification strategy, this analysis has a number of other limitations. First, the mechanisms of female-headed households' exclusion patterns (and the possible policy implications of this) should be further investigated. Second, alternative indicators of within-household women empowerment can be used. Some of them, unfortunately, show too little variation, *e.g.* land titling of plots in a man's or woman's name. Some other indicators cannot be constructed because of a lack of appropriate data (*e.g.* time use patterns that would allow one to see whether the workload of women is significantly affected by contract farming. Last, but not least, a similar analysis with more recent data might show what changes have occurred in the last decade.

In terms of policy, this work does not aim to reach a conclusion about the pros and cons of contract farming. It simply underlines that emerging market opportunities per se do not mean that women will necessarily be included and empowered or that gender inequalities will be reduced. Deliberate actions are likely required for these outcomes. Analysis of possible actions is beyond the scope of this work, but it is important for future research.

ACKNOWLEDGEMENTS

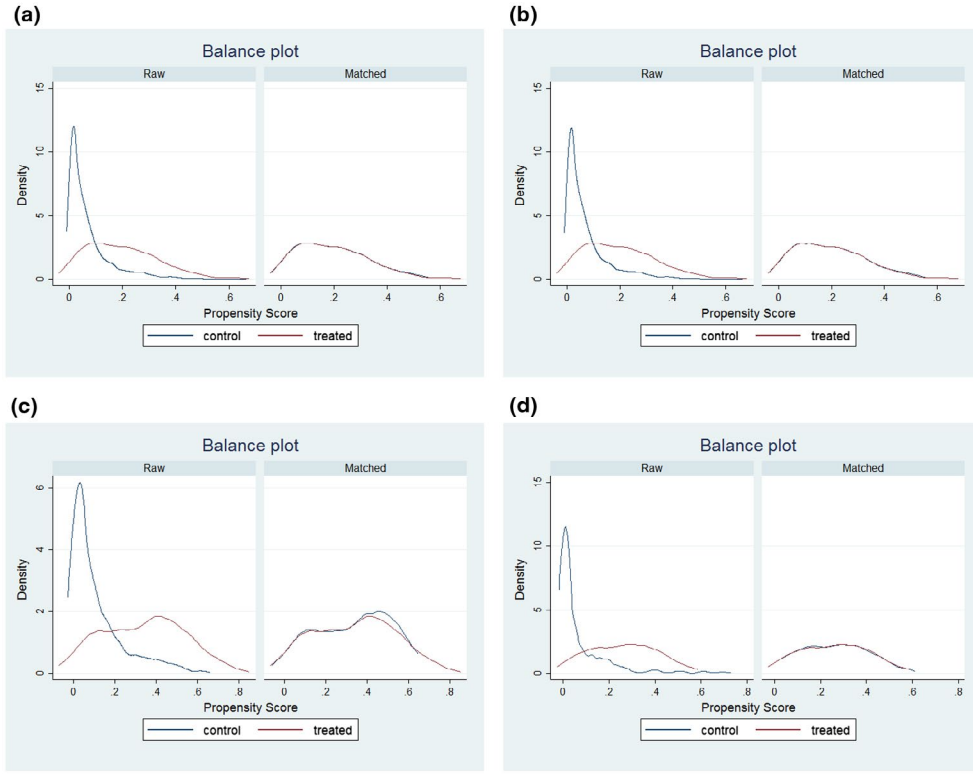
This work has been possible thanks to the UNU-WIDER visiting scholar program. I especially acknowledge the valuable suggestions from Carlos Gradìn, Miguel Niño-Zarazúa, Vincenzo Salvucci, Ricardo Santos, Saurabh Singhal and Finn Tarp. I thank the participants to the conference 'Poverty and inequality in Mozambique: What is at stake?' in Maputo (November 2017) and especially Servaas van der Berg for his useful comments. I also thank Benedito Cunguara for his support on the data, The Nordic Africa Institute (Uppsala, Sweden), where I conducted part of the writing, and the participants to two seminars (at the Department of Development Studies of the University of Helsinki and at SLU in Uppsala). I am grateful to two anonymous referees for their precious comments. Any errors and omissions are the author's alone.

REFERENCES

ABADIE, A. (2005). Semiparametric difference-in-differences estimators. *Review of Economic Studies*, 72: 1–19.
ABADIE, A. and IMBENS, G. W. (2016). Matching on the estimated propensity score. *Econometrica*, 84(2): 781–807.
ARNDT, C., BENFICA, R. and THURLOW, J. (2011). Gender implications of biofuels expansion in Africa: the case of Mozambique. *World Development*, 39(9): 1649–1662.
BAULCH, B. and QUISUMBING, A. (2011). Testing and adjusting for attrition in household panel data. *CPRC Toolkit Note*, The Chronic Poverty Research Centre.
BELLEMARE, M. F. (2012). As you sow, so shall you reap: The welfare impacts of contract farming. *World Development*, 40(7): 1418–1434.
BENFICA, R., TSCHIRLEY, D. and BOUGHTON, D. (2012). Interlinked transactions in cash cropping economies: the determinants of farmer participation and performance in the Zambezi river valley of Mozambique. International Association of Agricultural Economics, August, Gold Coast (Australia). East Lansing: Department of Agricultural Economics, Michigan State University.
BOUGHTON, D., MATHER, D., BARRETT, C. B., BENFICA, R., ABDULA, D., TSCHIRLEY, D. and CUNGUARA, B. (2007). Market participation by rural households in a low-income country: An asset-based approach applied to Mozambique. *Faith and economics*, 50(1): 64–101.
DE BRAUW, A. (2015). Gender, control, and crop choice in northern Mozambique. *Agricultural Economics*, 46(3): 435–438.
BRIONES, R. M. (2015). Small farmers in high-value chains: binding or relaxing constraints to inclusive growth? *World Development*, 72: 43–52.
CUNGUARA, B. and HANLON, J. (2010). *Poverty is not being reduced in Mozambique*. Crisis State Working Paper Series, n. 2. Department of International Development, London School of Economics and Political Science, London.
DANIEL, J. (2001). Baixas e álcool: género, mateka e culturas de rendimento no Distrito de Mueda, Provincia de Cabo Delgado', in Waterhouse Rachel, Vijfhuizen Carin (dir.), Estratégias das mulheres, proveito dos homens. Genero, terra e recursos naturais em diferentes contextos rurais em Moçambique, UEM, Maputo, 211–234.
DARITY, W. JR. (1995). The formal structure of a gender segregated low-income economy. *World Development*, 23(11): 1963–1968.
EVERS, B. and WALTERS, B. (2000). Extra-household factors and women farmers' supply response in sub-Saharan Africa. *World Development*, 28(7): 1341–1345.
FAO (2005). Agricultural Censuses and Gender: Lessons Learned in Africa. Rome: Food and Agriculture Organization of the United Nations.
_____ (2011). The state of food and agriculture. Women in Agriculture: Closing the Gender Gap for Development. Rome: FAO.

GIESBERT, L. and SCHINDLER, K. (2012). Assets, shocks, and poverty traps in rural Mozambique. *World Development*, 40(8): 1594–1609.
HILL, C. (2011). Enabling rural women's economic empowerment: institutions, opportunities, and participation. Background paper prepared for the UN Women Expert Group Meeting, Accra, Ghana, 20–23 September.
HOUNGBEDJI, K. (2016). Abadie's semiparametric difference-in-differences estimator. *Stata Journal*, 16(2): 482–490.
KEY, N. and RUNSTEN, D. (1999). Contract farming, smallholders, and rural development in Latin America: The organization of agroprocessing firms and the scale of outgrower production. *World Development*, 27(2): 381–401.
LEUVEN, E. and SIANESI, B. (2003). psmatch2: Stata module to perform full Mahalanobis and propensity score matching, common support graphing, and covariate imbalance testing. http://ideas.repec.org/c/boc/bocode/s432001.html
MAERTENS, M. and SWINNEN, J. (2012). Gender and modern supply chains in developing countries. *Journal of Development Studies*, 48(10): 1412–1430.
MATHER, D., CUNGUARA, B. and BOUGHTON, D. (2008). Renda e activos de agregados familiares rurais em Moçambique, 2002–2005: É possível sustentar o desenvolvimento a favor dos pobres? (No. 97146). Michigan State University, Department of Agricultural, Food, and Resource Economics.
MORGADO, J. and SALVUCCI, V. (2016). *Gender divide in agricultural productivity in Mozambique*. WIDER Working Paper 2016/176. Helsinki: UNU-WIDER.
NAVARRA, C. (2017). *Contracts between smallholders and private firms in Mozambique and their implications on food security*. WIDER Working Paper 2017/197. Helsinki: UNU-WIDER.
NAVARRA, C. and PELLIZZOLI, R. (2012). 'Integrating smallholders in rural markets in Mozambique: empowering women or further marginalizing them?' On-line proceedings of the IIIrd IESE Conference 'Moçambique: Acumulação e Transformação num. *Contexto de Crise Internacional*, Instituto de Estudos Sociais e Economicos, Maputo, Mozambique.
NJUKI, J., KAARIA, S., CHAMUNORWA, A. and CHIURI, W. (2011). Linking smallholder farmers to markets, gender and intra-household dynamics: Does the choice of commodity matter? *European Journal of Development Research*, 23: 426–443.
OYA, C. (2012). Contract farming in sub-Saharan Africa: A survey of approaches, debates and issues. *Journal of Agrarian Change*, 12(1): 1–33.
PROWSE, M. (2012). Contract farming in developing countries: A review. Agence Française de Développement
RAVALLION, M. (2007). Evaluating anti-poverty programs. *Handbook of Development Economics*, 4: 3787–3846.
RAYNOLDS, L. T. (2002). Wages for wives: Renegotiating gender and production relations in contract farming in the dominican republic. *World Development*, 30(5): 783–98.
. RÉPUBLICA DE MOÇAMBIQUE (2005).Estratégia de género do sector agrário. Unidade de género do Ministério da Agricultura, Maputo.
_____ (2011). Plano estratégico para o desenvolvimento do sector agrário (PEDSA). Maputo: Ministério da Agricultura.
SCHNEIDER, K. and GUGERTY, M. K. (2010). Gender and contract farming in Sub-Saharan Africa. Literature Review. Paper prepared for the Farmer Productivity Team of the Bill and Melinda gates Foundation, Evans School of Public Affairs, University of Washington, March 8.
SMALLEY, R. (2013). Plantations, contract farming and commercial farming areas in Africa: A comparative review. Land and Agricultural Commercialization in Africa. Future Agricultures Consortium. Brighton, UK: University of Sussex.
WARNER, J. M. and CAMPBELL, D. A. (2000). Supply response in an agrarian economy with non-symmetric gender relations. *World Development*, 28(7): 1327–1340.
WARNING, M. and KEY, N. (2002). The social performance and distributional consequences of contract farming: An equilibrium analysis of the Arachide de Bouche program in Senegal. *World Development*, 30(2), 255–263.
WORLD BANK (2007). World Development Report 2008: Agriculture for Development. Washington, DC: World Bank.

APPENDIX



A1 (A–D) Balance plot of the propensity scores in Table 9. (a): Col. 1 of Table 9 Y = At least one plot is under the responsibility of a woman also for selling (20015). (b): Col. 2 of Table 9 Y = Change in the number of plots managed by a woman (2005–2002) (same sample as Col.1). (c): Col. 3 of Table 9 A woman receives extension services (2005) (the sample excludes households that do not receive extension services). (d): Col 4 of Table 9 A woman is part of a producers association (2005) (the sample excludes households where there are no association members) [Colour figure can be viewed at wileyonlinelibrary.com]

Table 13. Probit model used to estimate the propensity score Table 9

	(1)
VARIABLES	**contract farming in 2005**
Female-headed household in 2002	−0.438***
	(0.117)
Age household head in 2002	−0.0119***
	(0.00301)
Education household head 2002 (level 1)	−0.160*
	(0.0885)
Education household head 2002 (level 2)	0.0163
	(0.153)
Education household head 2002 (level 3)	−0.193
	(0.290)
Size of the household 2002	0.0271*
	(0.0139)
Land size (ha) 2002	0.00790
	(0.0124)
Number of plots 2002	0.0960***
	(0.0315)
Owns a lamp? 2002	−0.165**
	(0.0831)
Owns a radio? 2002	−0.0311
	(0.0831)
Owns a wc? 2002	0.135
	(0.0885)
Has irrigation (at least on one plot)? 2002	−0.206
	(0.135)
Hires workers? 2002	0.0253
	(0.100)
Uses animal traction? 2002	0.236
	(0.151)
Uses fertilizers? 2002	0.446**
	(0.176)
Is association member? 2002	−0.124
	(0.189)
Received information on prices? 2002	0.228***
	(0.0833)
Are there non-farm workers in the household? 2002	−0.272**
	(0.118)
Produces cash crops? 2002	0.565***
	(0.0851)
Food production per capita 2002	0.000286**
	(0.000131)
Income 2002	−6.06e−06*
	(3.35e−06)
Constant	−2.439***
	(0.309)
PROV FE	YES
Observations	3,120

Note: Standard errors in parentheses.

***p < 0.01 **p < 0.05 *p < 0.1.