Favoritism and Farming: Agricultural Productivity and Polygyny in Tanzania

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Abstract

Women make an important contribution to household food production in Sub-Saharan African. However, women's agricultural productivity may be reduced by polygyny and limited intra-household bargaining power, both of which can determine the amount of agricultural inputs allocated to household plots. Under Pareto efficiency, two plots of the same size and characteristics should yield the same size output, regardless of the gender or wife order of the plot manager. Using three waves of the Tanzania Living Standards Measurement Survey- Integrated Survey on Agriculture, we explore the effect of the number of wives and plot management on agricultural productivity and inputs for farming households in Tanzania. We find that polygyny has an negative effect on crop value and that this effect can be explained by lower levels of inputs into plots that are managed by women.

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1 Introduction

Women play a key role in Sub-Saharan African food production, where they make up the majority of small-scale farmers and produce 60 to 70 percent of the food supply (Gawaya, 2008). This large contribution to agricultural production is viewed as a contributing source of the persistence of polygyny (Jacoby, 1995). Gendered determinants of intra-marriage bargaining power, such as education, large age differentials, and lack of access to credit may have a negative effect on women's agricultural productivity. Polygyny can alter the bargaining power structure within the household through the additional resource competition, or improved cooperation, or both. However, it is not yet clear what effect polygyny has on the distribution of agricultural resources across plots managed by men and women in the same household. We explore the effect of the number of wives, wife order and joint plot management on agricultural productivity for farming households in Tanzania.

This paper builds on a well-established body of literature that examines the sources of agricultural productivity differences between men and women. Led by the seminal work of Udry (1996), a number of studies (Quisumbing and Maluccio, 2003; Akresh, 2005; Rangel and Thomas, 2012) test for Pareto efficiency through comparisons of agricultural yield differences across plots within households. Efforts to achieve efficiency may be complicated by the household structure and the family heirarchy of polygyny. Akresh et al. (2011) find that, in Burkina Faso, polygynous households have lower yield differences between spouses and thus are more productively efficient than monogamous households. This result stands in contrast to the findings by Peterman et al. (2011); they conclude that the differences in agricultural productivity between men and women in Uganda and Nigeria are, in fact, driven by the less efficient polygynous households in both countries. Dauphin (2013) finds mixed evidence of the effect of polygyny on yield in Benin, Burkina Faso, and Senegal. Her explanation is that the influence of polygyny on intra-household efficiency is subject to cultural context, which is often determined by tribe, geography and local norms. While these papers provide an excellent starting point for an examination of agricultural productivity differences between monogamous and polygynous households, it is not yet clear what effect wife order has on allocative efficiency across plots that are jointly managed in polygynous households.

Cooperation among co-wives in a polygynous household would be most efficient; however, the anthropological evidence indicates that co-wife relationships within polygynous households in Sub-Saharan Africa are often characterized by negative competition and conflict. Jankowiak et al. (2005) and Kazianga and Klonner (2009) find evidence of competition and an unequal distribution of wealth across co-wives. Rates of polygyny are declining in Tanzania, but the practice is still common. According to the Social Institutions and Gender Index (SIGI) of the OECD, 23 percent of Tanzanian women were in polygynous marriages in the 2004-2005 Demographic and Health Surveys (DHS), a drop from 29 percent during the 1990s. To better understand the role of polygyny in household production in Tanzania, we measure its effect on agricultural allocative efficiency across plots, and as a function of each person's position in the household. In this paper, we present the results using ordinary least square (OLS) and instrumental variables (IV) estimation, using religion as an instrument for polygyny. However, having requested special permission to have access to the ethnicity variable in the LSMS-ISA Tanzania data, we expect to have a more precise instrument of polygyny within the next month.

Extremely few plots are managed solely by women, thus this analysis compares the effect of polygyny on jointly managed plots (jointly managed by the husband and at least one wife) versus male-only managed plots. Plot management in the sample was determined by the survey question "who decided what to plant on this plot?" Forty-eight percent of crops are managed jointly by husbands and wives. Although ownership and decision-making may be subject to reporting bias, these measurements are commonly used in the literature. In this sample, the average number of wives in married households is 1.22 in 2009, 1.23 in 2011 and 1.25 in 2013. We examine the effect of resident wives (wives living in the sampled household) in the of polygyny, which limits the number of wives in this sample to two.* Additionally, most second wives that manage plots, do so with the first wife as well (89 percent). However, for households that have two wives, only eight percent of the first wife's jointly managed plots are also jointly managed with the second wife.

Although there is a large literature on the effect of polygyny on agricultural productivity in

*Fifty three percent of polygynous households in the sample include all of the husband's wives (i.e. do not have non-resident wives). Thus, in about half of all polygynous households, a husband has other wives who are not counted in this analysis. The definition of a household, according to LSMS-ISA is "people who live together and share income and also basic needs. In other words, residents of a household share the same center of production and consume from that center."

West Africa, we expand this test for efficiency to the East African context and, to the best of our knowledge, this is the first paper to do so using agricultural data. I also build on the understanding of household intra-household power structures by examining the effect of joint plot management by the first and second wife, exploiting differences in bargaining power and seniority within the household.

2 Conceptual Framework

In the conceptual model, similar to that of Udry (1996), we develop the conditions that should hold if the household is operating plots efficiently. I then test whether the number of wives or joint management in the household has an effect on the efficient allocation of resources. For the sake of understanding the intra-household relationship between men and women, we limit the household size in this model to three: a husband and two wives.

Each person in the household has his/her own utility function:

$$U_h(C_h, C_{w1}, C_{w2}, Z) \tag{1}$$

$$U_{w1}(C_h, C_{w1}, C_{w2}, Z) \tag{2}$$

$$U_{w2}(C_h, C_{w1}, C_{w2}, Z) \tag{3}$$

where:

$$h = husband;\ w_1 = wife\ 1;\ w_2 = wife\ 2 \tag{4}$$

The arguments of the household utility function are as follows: C is the consumption of private goods and Z is the consumption of a public good. Total labor for each individual, N is fixed and thus does not appear in the utility functions. Consumption and labor supply are indexed specifically for each member of the household. Total consumption of private goods is constrained by:

$$C = C_h + C_{w1} + C_{w2} \tag{5}$$

Public good production (i.e. cooked meals or a clean house) within the household is determined by the labor allocated from each household member:

$$Z = Z(N_{w1}^Z, N_{w2}^Z, N_h^Z) \tag{6}$$

Production (Y) of crop k in the household is defined as:

$$Y^k = \Sigma_{i \epsilon P^k} B^k(N_{w1}^i, N_{w2}^i, N_h^i, A^i, T^i) \tag{7}$$

Here, i is an index for different plots of land controlled by the household, for production of some crop, k; P^k denotes the set of plots on which k is grown. N indicates husband and wives' labor applied to plot i, A is the land area of plot i, and T is the amount of inputs (e.g. fertilizer) allocated to plot i. B^k is the production function and is assumed to be concave in all arguments. The technology of production is permitted to vary across crops, but not across plots within a single crop. The restrictions for male and female labor supply are a function of time spent on plots and on household public good production:

$$N_{w1} = N_w^z + \Sigma_{i=1}^I N_{w1}^i \tag{8}$$

$$N_{w2} = N_w^z + \Sigma_{i=1}^I N_{w2}^i \tag{9}$$

$$N_h = N_h^z + \Sigma_{i=1}^I N_h^i \tag{10}$$

This restriction implies that household labor can be allocated to either production of the household public goods or to farming across all plots, i. Without leisure in the model, the total amount of labor allocation for each household member is fixed. This simplification implies that individuals choose between allocating time to the household public good or to plots. Similar to Udry (1996), this framework assumes that there are no labor or land markets.

The maximization problem is also subject to the household budget constraint:

$$p \cdot C \leq p \cdot Y \tag{11}$$

A cooperative household, which by definition is efficient, would have a kind of sharing rule that is based on a household utility function that is a weighted average of the utilities of the three members. Thus, the household needs to choose C_{w1}, C_{w2}, C_h; N_{w1}, N_{w2}, N_h for each plot; and N^z_{w1}, N^z_{w2}, N^z_h, to maximize:

$$U = \mu_1 U_h(C_h, C_{w1}, C_{w2}, Z, N_h, N_{w1}, N_{w2}) + \mu_2 U_{w1}(C_h, C_{w1}, C_{w2}, Z, N_h, N_{w1}, N_{w2}) + \mu_3 U_{w2}(C_h, C_{w1}, C_{w2}, Z, N_h, N_{w1}, N_{w2}) \tag{12}$$

$$\mu_1 + \mu_2 + \mu_3 = 1 \tag{13}$$

Maximization of this household utility function (2) is subject to the budget constraint (11), production technology (7), household labor conditions (8)-(10) and technology for producing Z public goods (6). Equation 13 is a normalization. There is no leisure in this model. If the household is operating efficiently, this maximization problem implies that the household would choose the same allocation of inputs over these plots as the production maximization problem (maximizing the crop production function, B^k, subject to optimal aggregate labor allocations to each crop). In other words, conditional on optimal amounts of inputs and of each of the three types of labor to each crop, efficiency implies that household utility is maximized if labor and agricultural inputs are allocated across plots in which crop k is grown in the way that also maximizes production of that crop.

Additionally, if I assume that B^k is increasing in all arguments, and strictly increasing in land area, A^i, then, under Pareto efficiency, two plots of the same size and characteristics should yield the same output, regardless of the gender of the cultivator. This leads to the main testable hypothesis:

Hypothesis 1 Conditional on inputs, if the cooperative household model holds, the gender and wife order of the plot managers (and thus, whether the plot is jointly managed by the first wife or the second wife) should not be a significant predictor of yield.

The standard separation result of an agricultural household model should hold, where production decisions are independent of preferences within the household.[†] Any differences in yield based on whether the plot is jointly managed will thus be evident of intra-household allocative inefficiency.

3 Empirical Approach

This paper uses the Tanzania National Panel Survey (TZNPS), which is one of the LSMS Integrated Surveys on Agriculture (LSMS-ISA), to examine households' distribution of agricultural inputs across plots in polygynous and monogamous households. Using the three waves of this household survey, 2008-2009, 2011 and 2013, allows the ability to examine the effect of longitudinal household changes in marital status, such as entering into a monogamous marriage or gaining an additional wife.

The TZNPS was initiated to provide comprehensive high-quality household-level data to the government of Tanzania, with the aim of evaluating policy initiatives to alleviate poverty. The nationally representative survey includes a wide range of information on household characteristics, including family composition, labor, health and education. The agricultural data include land characteristics, outputs and inputs, separately for each plot. The data were collected for each crop planted on a specific plot. Information was also collected about the management of the plot (who decides what to plant), as well as crop-level information such as the quantity harvested and the area (acreage) on which that crop was harvested. Multiple crops are often harvested on a single plot. When the data have been matched across waves, plots and crops, the sample includes 891 households, 1283 plots and 1603 crop-level observations. The main outcomes of interest are yield (measured as kilograms per acre), fertilizer used per acre (kilograms per acre), labor applied per acre (person-days of labor) and total crop value (using farmer-estimated prices for all crops). The outcome variables are logarithmically-transformed using the inverse hyperbolic sine function to

[†] This assumes that hired labor is a perfect substitute for household labor.

adjust for a large number of zeros.

As indicated above, the assumption of household production efficiency implies that variations in yield across plots or crops should be explained entirely by plot or crop characteristics. We examine whether this holds by evaluating the difference in yields between joint and husband-only plots. Here I examine equal yield for plots (i), defining yield per unit of land as $Q^k(A^i)$:

$$Q^k(A^i) = (B^k[N^i_{w1}(A^i), N^i_{w2}(A^i), N^i_h(A^i), T^i(A^i)])/A^i \tag{14}$$

If the cooperative household model holds, the yield of plot i of household h for crop k should depend only on the plot characteristics and input quantities, not on the number of wives or wife order of the plot manager. Using this definition of yield, we can test whether polygyny, joint management and wife order affect the yield on the plot. In a second test of Pareto efficiency, we test whether polygyny affects the use of agricultural inputs such as labor, fertilizer and pesticide. Differences in agricultural input allocation for joint and husband-only plots would indicate greater or lesser extents of allocative efficiency in polygynous households.

We first estimate the 2009 cross-sectional effect of the number of wives on the yield of crop k in year t for household h on plot i by running the following ordinary least squares regression:

$$Q_{htki} = \beta_1 X_{htki} + \beta_2 G_{htki} + \beta_3 F_{htki} + \epsilon_{htki} \tag{15}$$

Here, X represents plot characteristics, G is an indication of a plot jointly managed with husband and wife, F represents the number of wives. The effect of the number of wives is captured by the parameter β_3, and β_2 represents the effect of joint plot management on yield, Q. As the final agricultural outcome, yield should capture any allocative inefficiencies across plots, however, we also test for allocative inefficiency using the same regression with fertilizer, labor and total crop value as outcomes. Equation (15) represents a cross-sectional test of Pareto efficiency within the household. Efficiently producing polygynous households are then given by ($\beta_2 = \beta_3 = 0$). The possible effects of polygyny are the following:

$$\beta_3 < 0;\ \text{polygynous households are less efficient} \tag{16}$$

$$\beta_3 = 0;\ \text{polygyny has no effect} \tag{17}$$

$$\beta_3 > 0;\ \text{polygynous households are more efficient} \tag{18}$$

The possible effects of the number of wives and of joint management are suggested by the previously described anthropological and economic accounts of polygynous households. For example, the scenario described in equation (18) may be explained by greater cooperation between wives in polygynous households (Akresh et al., 2011). Alternatively, polygyny could be a source of conflict that jeopardizes overall productivity, which would result in equation (16). It is possible that β_2 and β_3 have opposite signs. If $\beta_2 < 0$ and $\beta_3 > 0$, then the polygyny has a positive effect on yield, but joint management has a negative effect on yield, implying a possible cooperation benefit of additional persons in the household, but an inefficient allocation of agricultural inputs. And if $\beta_2 > 0$ and $\beta_3 < 0$, then polygyny has a negative effect on yield and joint management has a positive effect on yield, implying that additional wives may reduce productivity but jointly managed plots are more efficient.

In a more narrow analysis to understand the effect of wife order in polygyny, we measure the differential effects of the first and the second wife joint management on agricultural productivity with interaction terms. To do this, we estimate the following equation:

$$Q_{htki} = \beta_1 X_{htki} + \beta_2 G_{1htki} + \beta_3 G_{2htki} + \beta_4 F_{htki} + \beta_5 (F_{htki} * G_{1htki}) + \beta_6 (F_{htki} * G_{2htki}) + \epsilon_{htki} \tag{19}$$

In this estimation, β_2 represents the effect of joint management of the husband with the first wife and β_3 represents the effect of joint management of the husbanda with the second wife.[‡] And as previously stated, the analysis of resident wives limits the sample to households with a maximum of two wives. First wives tend to have the most seniority, thus, the effect of joint plot

[‡]As indidcated in the introduction, most plots that are managed by the second wife with husbands are also managed by the first wife. So effectively, this is the effect of joint management between three people.

management with a first wife is likely to be different than the effect with a second wife. I expect that the coefficient on joint management for wife 1 (β_2) to be negative for the first wife, implying that joint management would results in lower agricultural input allocations and that this would negatively affect yield. These results would corroborate those of Udry (1996). As an extension of the traditional model, I expect that this term for the second wife, (β_3) to be positive, implying that the involvement of the second wife in joint management would have a positive effect on yield and inputs. In a household with two resident wives, I hypothesize that having the second wife also as a plot manager is an indicator of concentrated effort on production for that plot. Additionally, β_5 and β_6 capture the effect of wife order interacted with jointly-managed plots. Again, Q_{htki} represents the main agricultural outcomes (maize yield, fertilizer, labor and crop value) for household h, crop k, plot i at time t.

To account for time-invariant characteristics of households, plot and crops that affect agricultural yield, I combine all three years of data and estimate the following regression with fixed effects:

$$Q_{hti} = \beta_1 X_{hti} + \beta_2 G_{1hti} + \beta_3 G_{2hti} + \beta_4 F_{hti} + \beta_5 (F_{hti} * G_{1hti}) + \beta_6 (F_{hti} * G_{2hti}) + \alpha_{hi} + \epsilon_{hti} \tag{20}$$

where α_{hki} is a fixed effect pertaining to household h and plot i. This regression is estimated over three waves of data, where t represents year. The fixed effect captures the average household and plot average levels of covariates over the three years, thus X represents the effect the changes in the covariates over the three years of observation. In this model, β_2 and β_3 represent the effect of changes in joint management with the first and second wife in the household. I again anticipate in this fixed effects model that the coefficient on joint management with the first wife would be positive and that the coefficient on joint management with the second wife would be negative. Finally, β_5 and β_6 capture the interaction effect of jointly managed plots and changes in the number wives. Table **??** estimates equation (20) for outcomes maize yield, fertilizer use, labor use and crop value.

In the examination of the effect of a household characteristic, such as number of wives and joint management, on yield, it is important to understand directionality of bias. Polygyny is likely to be correlated with unobserved characteristics of the household such as wealth,[§] preferences for family size and farmer quality that may affect yield (Jacoby, 1995; Akresh et al, 2011). Polygyny has been instrumented in the literature by quantity of land inherited and ethnicity (Akresh et al, 2011; Dauphin, 2013). Ethnicity, although collected in the LSMS-ISA, is not publicly released.[¶] Quantity of land inherited was also collected, but only 3 percent of agricultural households answered this question (possibility to due sensitivity issues around land ownership in Tanzania). I did perform the analysis using the ratio of boys to girls in a household and religion as instruments for polygyny, but the instruments often had weak explanatory power that resulted in low F-statistics.

In Tanzania, polygyny is an expensive investment due to bride prices. It is common practice for husbands to pay a bride price (ten to fifty cattle) to the parents of the new wife. Because of this, polygyny is highly correlated with wealth. Although I control for household consumption in all regressions, it is likely that the error term captures unobserved wealth that is positively correlated with yield and agricultural inputs. Wealthier farmers are likely to have better knowledge of cultivation practices and are likely to be more able to afford purchasing agricultural inputs such as hired labor and fertilizer. In this case, the observed coefficient on total wives would over-estimate the effect of polygyny on yield and agricultural inputs. This omitted variable bias would also over-estimate the effect of joint management on yield and agricultural inputs as well. Another possible source of bias is reverse causality. Larger yields may give way to the ability to afford an additional wife. This would also result in an overestimate of the impact of polygyny on yield. Measurement error is the final source of bias in this estimation strategy. Imprecise estimates of land area, amounts of harvested crops, and prices, in addition to recall bias in use of agricultural inputs may either upwardly or downwardly bias the estimate of the impact of polygyny and joint management on agricultural productivity.

The current analysis includes cross-sectional analysis for multiple years and a household-crop-plot fixed effect regression to measure changes over time. The cross-sectional analysis only controls

[§]Although I control for monthly household consumption, wealth is not directly observed.

[¶]We have requested the variable from the Director General of NPS in Tanzania and are waiting for permission to be granted.

for observable plot and household characteristics in the estimation of the impact of polygyny on agricultural productivity. However, the fixed effects model accounts for time-invariant unobservable household, plot and crop-level characteristics.

4 Results and Discussion

Table 1 shows plot and household descriptive statistics over the time period of the panel. The average number of wives in the entire sample is .778 in 2009, .841 in 2011 and .90 in 2013. And as households increase the number of wives (or enter into marriages), they also jointly manage more of their plots. In 2009, 35.5 percent of plots are jointly managed, but by 2013, 52.3 percent of plots are jointly managed. These changes in household dynamics and plot level management over time allow us to measure the effect of polygyny on agricultural productivity.

First, we examine the effect of polygyny and joint management on crop value using the household-plot fixed effect. The fixed effect term in this estimation captures the average levels of each household and plot, thus the resulting coefficients show the impact of the variation over time of that household characteristic from its household-level mean. Thus, any covariate that does not change over time is dropped from the regression. Eight percent of husbands added a wife between 2009 and 2013. Sixteen percent of plots became jointly managed with a wife between 2009 and 2013. In the first two columns of Table 2, we show results for the OLS (all crop values) and OLS (only positive crop values) estimations. We also implemented an instrumental variable regression, using religion (Muslim) as the instrument. In column (3), we show the results of the first stage equation and in column (4), we show the results after polygamy is instrumented. Polygamy has a negative effect on crop value throughout all specifications, although it is only statistically significant when the observations with zero crop value are omitted. Joint management of plots with the second wife has a positive effect on crop value, as anticipated. This effect is statistically significant in both the OLS and the IV specifications.

To understand the explanations of reduced crop value for polygynous households, we explore its effect on inputs of labor and fertilizer. The effect of polygyny on labor is shown in Table 3. Using similar regression specifications as above, we can see that polygyny and joint management do not appear to have a statistically significant effect on labor allocation to plots. This is surprising given the increase in available farm labor that are often associated with marriages. In Table 4, we display the estimation results for the effect of polygyny on fertilizer use. In the non-zero OLS estimation, we show that polygyny is negatively associated with fertilizer use (and this effect is statistically significant at the 10 percent level). However, after instrumenting polygyny with religion, this effect is no longer statistically significant.

Finally, we show the effect of polygyny on other types of agricultural inputs in Table 5. Plots that are jointly managed by the first wife are associated with less modern seed types and smaller plot sizes. The effect of joint management with the first wife is negative for quantity of crops and soil quality as well, although not significant.

Because this fixed effects estimation includes three observations for each household and plot over the time period, these estimated effects do not distinguish between actual effects of polygyny and changes in household dynamics, or agricultural production over time. For example, it is possible that the household grew less lucrative crops in 2013 than in 2009, which contributed to lower values of crops.

5 Conclusion

Polygyny can alter the bargaining power structure within a poor agricultural household through resource competition or through cooperation and additional labor. we estimate the effect of the number of wives in a household, wife order and joint plot management on agricultural productivity for farming households in Tanzania. The results showing the effect of polygyny suggest that it is associated with lower crop value and that this may be explained by fewer inputs on plots in polygamous households that are managed by women. With smaller amounts of fertilizer, access to lower quality seeds, less inter-cropping and lower quality soil, female farmers in polygynous households are unable to produce high valued crops.

I expected that joint management with the first wife would be associated with lower agricultural productivity and input allocation, as a reflection of inefficient allocation of resources to plots that are (at least partly) managed by women. These results are in agreement with (Udry, 1996). We also expected that joint management with the second wife would have an inverse effect and would be associated with higher yield and input allocation, as an indicator of focused efforts of the entire household on that crop. Joint management of plots with the second wife has a positive effect on crop value, while joint management with the first wife has an overall negative effect on crop value. After obtaining the ethnicity variable from LSMS-ISA (expected within the next month), we will be able to measure the effect of polygyny with less bias.

The policy implications of this research pertain to farming extension and education services. Most extension services related to improved cultivation practices in Tanzania are tailored to men as the main audience. However, because half of all plots in this Tanzanian sample are managed by both husbands and wives, these extension services should reach all members of the household. Improved seeds, use of fertilizer and good soil practices all positively affect agricultural outcomes, regardless of plot manager. Despite the existence of extension services in Tanzania, there remains a significant amount of crop loss and missing yields in this farming data. All adult members of the household would benefit from farming extension and education services.

The results in this study expand on the concept of intra-household bargaining power by exploring marriages with more than two members. More research is needed to better understand the effect of additional wives on agricultural productivity, perhaps in samples with a larger sample of polygynous households and more variation in wives over time. I have built on the literature in polygyny and agriculture by investigating Pareto efficiency in polygynous households in East Africa, where the culture around household hierarchy is different from that in West Africa. I have shown that, perhaps changes in marital structure or hierarchy, these farming households exhibit signs of inefficiency as a result of polygny and jointly management plots.

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Table 1: Panel Descriptive Statistics

VARIABLES	(1) 2009	(2) 2011	(3) 2013
Yield	635.161	322.759	539.334
	(144.144)	(9.917)	(45.097)
Quantity of wives	0.962	0.980	0.962
	(0.015)	(0.015)	(0.015)
Quantity of fertilizer (IHS transformed)	1.117	0.816	1.290
	(0.048)	(0.039)	(0.048)
Farm size	6.010	6.541	7.834
	(0.242)	(0.223)	(0.342)
Crop value (IHS transformed)	9.581	8.405	9.803
	(0.100)	(0.108)	(0.100)
Soil is good quality	0.463	0.409	0.451
	(0.010)	(0.010)	(0.010)
Quantity of family labor (IHS transformed)	4.274	3.751	4.527
	(0.033)	(0.035)	(0.031)
Quantity of crops grown on plot	2.178	1.136	2.338
	(0.029)	(0.019)	(0.032)
Log monthly household consumption	10.214	10.108	10.325
	(0.014)	(0.011)	(0.011)
Plot is jointly managed	0.416	0.461	0.471
	(0.010)	(0.010)	(0.010)
Observations	2,337	2,678	2,634

Standard deviations in parentheses

Table 2: 2009-2011-2013 Panel Effect of Polygamy on Crop Value with Household-Plot Fixed Effect

VARIABLES	Crop Value OLS	Crop Value (>0) OLS	Polygamy First stage	Crop Value (>0) IV
Muslim			0.022***	
			(0.006)	
Polygamy	-0.168	-0.258**		
	(0.269)	(0.128)		
Joint management w wife 1	-0.049	0.011	0.009*	0.014
	(0.090)	(0.043)	(0.006)	(0.043)
Joint management w wife 2	0.706	0.618***	0.839***	0.494**
	(0.474)	(0.229)	(0.031)	(0.220)
Number of wives outside household	0.028	0.164*	0.557***	0.034
	(0.185)	(0.088)	(0.005)	(0.059)
Seed type	-0.026	-0.151***	0.007	-0.152***
	(0.071)	(0.034)	(0.005)	(0.034)
Log farm size	-0.368***	-0.383***	0.022***	-0.383***
	(0.072)	(0.035)	(0.003)	(0.035)
Plot was intercropped	-0.012	0.078	0.004	0.078*
	(0.100)	(0.047)	(0.006)	(0.047)
Soil is good quality	0.275*	0.265***	0.013	0.262***
	(0.162)	(0.077)	(0.011)	(0.077)
Crop loss	0.004	-0.066*	-0.001	-0.068*
	(0.082)	(0.039)	(0.006)	(0.039)
Steep slope	-0.303	-0.157	-0.005	-0.157
	(0.237)	(0.113)	(0.015)	(0.113)
Soil is avg quality	0.165	0.204***	0.014	0.199***
	(0.157)	(0.075)	(0.011)	(0.075)
Log monthly household consumption	0.170**	0.125***	-0.005	0.126***
	(0.070)	(0.033)	(0.005)	(0.033)
Number of children	0.023	-0.005	-0.002*	-0.004
	(0.043)	(0.020)	(0.001)	(0.020)
Plot size (acres)	-0.028**	-0.027***	0.002***	-0.027***
	(0.012)	(0.006)	(0.001)	(0.006)
Quantity of labor (IHS transformed)	0.050**	0.101***		0.101***
	(0.020)	(0.010)		(0.010)
Quantity of fertilizer (IHS transformed)	0.035*	0.070***		0.071***
	(0.021)	(0.010)		(0.010)
Constant	9.262***	10.032***	0.037	10.012***
	(0.763)	(0.365)	(0.048)	(0.365)
Observations	4,895	4,772	5,585	4,772
R-squared	0.075	0.272	0.691	
Number of id	1,765	1,753		1,753

Cluster-robust standard errors in parentheses *** p<0.01 ** p<0.05 *p<0.1
Geographic region and crop dummy variables are also included as covariates but not presented here.

Table 3: 2009-2011-2013 Panel Effect of Polygamy on Labor with Household-Plot Fixed Effect

VARIABLES	Labor OLS	Labor (>0) OLS	Labor (>0) IV
Polygamy	0.287	0.316	
	(0.244)	(0.243)	
Joint management w wife 1	0.012	0.005	0.002
	(0.082)	(0.082)	(0.081)
Joint management w wife 2	-0.102	-0.226	-0.072
	(0.430)	(0.429)	(0.413)
Number of wives outside household	-0.150	-0.188	-0.029
	(0.168)	(0.167)	(0.113)
Seed type	-0.179***	-0.167***	-0.166***
	(0.064)	(0.063)	(0.063)
Log farm size	-0.502***	-0.485***	-0.485***
	(0.065)	(0.065)	(0.065)
Plot was intercropped	-0.048	-0.051	-0.052
	(0.090)	(0.090)	(0.090)
Soil is good quality	0.061	-0.029	-0.025
	(0.147)	(0.147)	(0.147)
Crop loss	0.062	0.047	0.050
	(0.074)	(0.073)	(0.073)
Steep slope	0.280	0.249	0.247
	(0.215)	(0.214)	(0.214)
Soil is avg quality	0.052	-0.023	-0.017
	(0.142)	(0.142)	(0.142)
Log monthly household consumption	0.310***	0.327***	0.327***
	(0.063)	(0.063)	(0.063)
Number of children	0.020	0.030	0.029
	(0.039)	(0.038)	(0.038)
Plot size (acres)	-0.025**	-0.023**	-0.024**
	(0.011)	(0.011)	(0.011)
Quantity of fertilizer (IHS transformed)		0.063***	0.063***
		(0.019)	(0.019)
Constant	2.204***	2.018***	2.045***
	(0.690)	(0.687)	(0.686)
Observations	4,895	4,883	4,883
R-squared	0.121	0.126	
Number of id	1,765	1,765	1,765

Cluster-robust standard errors in parentheses *** p<0.01 ** p<0.05 *p<0.1

Table 4: 2009-2011-2013 Panel Effect of Polygamy on Fertilizer with Household-Plot Fixed Effect

VARIABLES	Fertilizer OLS	Fertilizer (>0) OLS	Fertilizer (>0) IV
Polygamy	-0.228	-0.813*	
	(0.234)	(0.453)	
Joint management w wife 1	0.079	0.055	0.078
	(0.079)	(0.175)	(0.175)
Joint management w wife 2	0.394	0.179	-0.416
	(0.414)	(0.906)	(0.844)
Number of wives outside household	0.273*	0.535*	0.177
	(0.161)	(0.281)	(0.198)
Seed type	0.043	0.642***	0.634***
	(0.062)	(0.139)	(0.139)
Log farm size	-0.110*	-0.651***	-0.647***
	(0.063)	(0.130)	(0.130)
Plot was intercropped	0.173**	0.213	0.218
	(0.087)	(0.181)	(0.181)
Soil is good quality	-0.128	-0.296	-0.316
	(0.141)	(0.305)	(0.305)
Crop loss	0.046	-0.049	-0.049
	(0.071)	(0.161)	(0.162)
Steep slope	-0.170	0.023	0.006
	(0.207)	(0.451)	(0.452)
Soil is avg quality	-0.123	-0.386	-0.418
	(0.137)	(0.291)	(0.291)
Log monthly household consumption	0.168***	0.261*	0.266**
	(0.061)	(0.135)	(0.135)
Number of children	0.001	-0.114	-0.119
	(0.037)	(0.088)	(0.088)
Plot size (acres)	-0.013	-0.012	-0.008
	(0.011)	(0.023)	(0.023)
Quantity of labor (IHS transformed)	0.060***	0.059*	0.056
	(0.017)	(0.034)	(0.034)
Constant	-0.742	2.841*	2.789*
	(0.665)	(1.539)	(1.541)
Observations	4,895	1,357	1,357
R-squared	0.055	0.286	
Number of id	1,765	718	718

Cluster-robust standard errors in parentheses *** p<0.01 ** p<0.05 *p<0.1

Table 5: 2009-2011-2013 Panel Effect of Polygamy on Plot Characteristics with Household-Plot Fixed Effect

VARIABLES	(1) Seed type	(2) Quantity of crops	(3) Plot size	(4) Soil quality
Polygamy	0.160	0.177	-0.604	-0.305
	(0.237)	(0.142)	(0.376)	(0.278)
Joint management w wife 1	-0.327***	-0.077	-0.224*	-0.090
	(0.079)	(0.048)	(0.128)	(0.095)
Joint management w wife 2	-0.944**	-0.297	-0.845	0.457
	(0.450)	(0.254)	(0.669)	(0.443)
Number of wives outside household	0.003	-0.184*	0.068	0.101
	(0.161)	(0.095)	(0.251)	(0.169)
Log farm size	-0.239***	-0.091**		
	(0.064)	(0.038)		
Plot was intercropped	0.183**	0.804***	0.305**	0.122
	(0.077)	(0.048)	(0.126)	(0.096)
Soil is good quality	0.470***	0.141	0.006	
	(0.140)	(0.087)	(0.231)	
Crop loss	0.374***	0.198***	0.294**	-0.140
	(0.071)	(0.044)	(0.115)	(0.085)
Steep slope	0.019	0.105	0.146	-0.028
	(0.198)	(0.126)	(0.333)	(0.228)
Soil is avg quality	0.219	0.165*	-0.037	
	(0.136)	(0.085)	(0.224)	
Log monthly household consumption	0.049	0.226***	0.194**	0.125*
	(0.060)	(0.037)	(0.098)	(0.072)
Number of children	-0.018	-0.035	0.076	-0.086**
	(0.036)	(0.023)	(0.060)	(0.044)
Plot size (acres)	0.018	0.061***		
	(0.012)	(0.007)		
Seed type			0.036	0.287***
			(0.092)	(0.067)
Constant		-0.707*	-0.112	
		(0.405)	(1.063)	
Observations	4,787	6,020	6,019	3,306
R-squared		0.125	0.011	
Number of id	1,727	2,493	2,493	1,196

Cluster-robust standard errors in parentheses *** p<0.01 ** p<0.05 *p<0.1