Constraints to Tanzanian Agricultural Development: Input Use in Households Under Non-Separability

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10 January 2020

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Friday 21st August, 2020

Abstract

This paper builds on the literature testing for labor market inefficiencies in developing countries using a panel data survey from Tanzania. Empirical tests first reject the homogenous contribution of family and hired labor to output, and then reject labor market 'separation' or completeness meaning that farm household production relies principally on family members for farming tasks. Nearly all empirical specifications are robust to the inclusion of household-specific effects, which control for heterogenous household preferences, and village-specific shocks. I also incorporate high-resolution annual population estimates from the LandScan database, which uses satellite imagery to construct population estimates, and find that in areas with higher population density, less family labor is used and more hired labor is used. JEL Codes J1, J43, O12, Q10, Q12, Q13, Q16

1   Introduction

Smallholder farms still account for a substantial share of labor in developing countries, and in many countries a majority of this labor is provided by family members. Starting with the original work by Chayanov (1986), who is considered to be the founder of modern agricultural economics, analysis of agricultural households' labor decisions dates back over a century in the quantitative microeconomics literature. The first empirical tests of separability were implemented by Benjamin (1992), who leveraged the separability hypothesis to show that farm labor decisions should be separable from household characteristics. The separation hypothesis implies that household production and consumption are separate processes and may be estimated separately. An alternative possibility is that household production and consumption are inter-linked through the budget constraint of the household. Analyzing household's labor choice is important to understand how the household interacts with labor markets, especially in remote parts of the country. It is also important to identify whether or not households are optimizing on plot characteristics or household characteristics, and additionally important to understand this dynamic in East Africa, a region where household separation tests are uncommon. Furthermore, Tanzania is a country with a large land area and high agricultural potential due to its moderate to tropical climate, and wide flat plains, meaning it has the potential to provide a source of food security for Tanzania and for the broader East African zone.

In this paper I analyze three major aspects of smallholder farms in Tanzania. First, I analyze the substitution of family and hired labor in different periods of the agricultural season, the pre-harvest season and the harvest period. Second, supported by the results of those tests, I analyze, using reduced form expressions for labor demand, whether household consumption and production are interlinked through labor allocation decisions, 'separable.' As part of those estimations, I utilize a remote-sensing dataset to estimate the effects of changes in population density on family and hired labor use. Last, I assess whether smallholder farms in Tanzania are constrained in their use of manure to fertilize plots. Since access to commercial fertilizers is limited, and they are relatively expensive for rural farmers, manure used to fertilize plots is considered an important investment.

If labor markets are incomplete, households must rely on family members to provide agricultural and other enterprise labor, which reflects that their demand for quality hired labor is

going unmet. By contrast, if markets were complete and farmers are profit maximizing, farm decisions about hired labor and other input use would be determined *exclusively* by farm characteristics and input prices including wages. If household production decisions rely on household parameters, such as the number of residents in the household or the wealth of the household, the number of livestock in the household's herd, the level of fitness or total education of the residents of that household, or their consumption levels, then we must estimate both consumption and production jointly in order to yield consistent results. An F-test or a likelihood ratio test of the exclusion restriction of all household parameters, or simply a T-test of any coefficient on household characteristics, rather than plot-level or farm-level characteristics, may therefore be interpreted as tests for separation. Benjamin notes that there can be several potential sources of separation in labor markets, this paper is principally molded around addressing those broad areas (1) a binding constraint on off-farm employment, (2) labor rationing, (3) and differences in the returns to on-farm and off-farm employment. Following the analysis of the separation of labor decisions from household characteristics, taking inspiration from Frisvold (1994), I analyze whether household characteristics affect manure use, another important input for small and medium-scale farmers, and analyze whether factor markets for manure could exist.

The most recent paper analyzing labor market completeness and the substitution of family labor for hired labor is LaFave and Thomas (2016) which was the first paper in the separation test literature to utilize panel data for separation tests. This paper is closest in spirit to the seminal paper by Benjamin (1992), which explored the relationship between family and hired labor use on rice-growing farms in Central Java (Indonesia) in the 1980s. As argued in Benjamin (1992) and Card et al. (1987), market prices and wages should function as indicators if markets are complete and efficient. If this type of signalling mechanism is in operation it should lead to a detectable 'separation' between household productive and consumption activities. This analysis is particularly potent when we can control for household-specific effects which control for unobserved household-level heterogeneity of taste and preferences.

The contributions of this paper are several: first this work builds on the analysis of labor market inefficiencies and extends the body of analysis on separation in agricultural labor markets in sub-Saharan Africa using a rich set of panel data. Similar to LaFave and Thomas (2016) I conduct analysis at the household level and village level, and include household fixed-effects and village fixed effects which control for household-specific and village-specific preferences.

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The data permit me to separate labor into to separate categories of preparatory period and harvest period labor for analysis. Different from other papers in the separation literature I estimate the elasticity of substitution between family and hired labor. Additionally, the Tanzanian LSMS dataset allows for the construction of precise managerial control variables since plot managers are included and may be matched with their details in the household roster. The inclusion of household-specific effects, village-specific effects, and managerial control variables allows me to control for both the potential bias that comes from household or village-specific preferences for work on the farm and the potential bias that might come from omitting managerial control variables from regressions. The last contribution is the integration of population density data using the LandScan dataset which is provided free to academic researchers by the OakRidge National Laboratory (ORNL). To the best of my knowledge this type of geospatial data has not yet been used to analyze labor market outcomes in developing countries.

The following section discusses the idea of separation and market completeness. I outline potential sources of separation, including differences in the marginal products of family and hired labor. I outline the meaning of separation in this context, and I discuss tests to examine explicitly the breakdown of differences in family and hired labor. In section 3 I give background on the datasets and data collection process. In section 4 I report results of tests for labor heterogeneity, and then I go on to report the results of tests for separation between household characteristics and labor supplied to the farm, and tests for the optimal allocation of fertilizer across all plots, and verify the existence of a relationship between household characteristics and fertilizer allocation (non-separability in manure markets). Section 5 discusses potential implications for agricultural policies and concludes.

2 Theoretical Background

2.1 Separation of Production and Consumption Activities

Research into rural agriculture is a popular subject in the development microeconomics applied and theoretical literature. This is because much of the developed world is still characterized as living in rural or subsistence farms, and some themes from farm-household dynamics apply in both developed and developing countries such as the well-known stylized fact that agricultural labor markets "tighten" during the harvest period. There is a vein of the develop-

ment economics literature which explores the market imperfections which affect these types of households. This paper will draw from the literature on market imperfections faced by rural agricultural households, with a specific focus on input markets including labor and manure. As argued in De Janvry and Sadoulet (2006), as well as in Thorbecke (1993), market failures are often the defining characteristics of these rural markets, and thus we cannot consider households without an understanding of potentially numerous market constraints which these households face.

Benjamin (1992) theorizes that there may be three principal sources of breakdowns in the labor market that lead to nonseparation: (1) a binding constraint on off-farm employment, (2) labor rationing, (3) and differences in the returns to on-farm and off-farm employment. With respect to point one, table 2 summarizes household labor activities. We can see that 36% of farm households have an unemployed member. Considering point 2, labor rationing could be a possible source of non-separation, particularly in the harvest season when farm-households may be unable to find laborers to help harvest the fields. Although the principal analysis of separation in this paper is with respect to labor markets, I also consider fertilizer factor markets as a source of potential separation between household-level variables and plot-level decisions. The first empirical test I employ is for the rationing question: are households reliant on family labor principally for their farming labor? With respect to a differential in returns to on-farm and off-farm employment, I check this by testing for a wage differential between household workers who work in agricultural jobs on other farms with the wage of hired-in labor who work on the household's farm.

I consider whether family and hired labor are perfect substitutes, as well as estimate the elasticity of substitution of family and hired labor. I will test whether household production relies principally on family labor, a common source of rejection for the separation tests, along with other household characteristics which should also not, except in the case of nonseparation, influence plot-level labor decisions. Last, I check whether a similar story exists for fertilizers. If total fertilizer use relies on household characteristics, such as the number of animals in the household herd.

2.1.1 Labor Demand Equations

With respect to the estimations of plot-level labor demand, the dependent variables are the log number of total family labor days, and the log of total hired labor days. The regressions take the following form for plot i in household h:

$$L_{ih}^{FAM,HIRED} = \beta N_{ih} + \delta X_{ih} + z_h + \eta_{vt} + \zeta_{hvt} \tag{1}$$

where N is vector of household characteristics, and X is a vector of other plot characteristics. In some equations subscripts for time and village are omitted for legibility. The regression includes a set of village-wave dummies η_{vt} and a set of crop dummies .

2.2 Labor Heterogeneity

Whether labor hired from the marketplace is comparable to family labor is an important question. If there exists a quality or skill differential between hired and family labor, this could contribute to the observation of separation. The literature on statistical tests analyzing the homogeneity of labor can be divided largely into two types of tests, what I have termed a Bardhan-Frisvold type test, and the Deolalikar-Vijverberg test. The first test, the Bardhan-Frisvold test, estimates a Cobb-Douglas production function, but assumes that the marginal products differ between family and hired labor. This method avoids an explicit estimation of the elasticity of substitution *between* hired and family labor, whereas the Deolalikar-Vijverberg test, which uses a simultaneous estimation procedure to estimate a labor services function, seems, *a priori*, less restrictive in the way it allows for substitution of family and hired labor, zero-labor inputs, and higher-order terms. As a result of the comprehensive nature of the LSMS dataset, I am also able to consider wages as a potential indicator of a quality or skill differential.

2.2.1 Bardhan-Frisvold Type Tests

Bardhan (1973) paper on farm size, farm productivity and the returns to scale also analyzes the heterogenous contributions of different labor types, and this paper estimates a Cobb-Douglas production function. Bardhan's paper, using Indian agricultural data from farm management surveys, the author finds that family and hired labor are *not* substitutable in West Godavari and

Thanjavur, but for the remaining districts in the sample the author cannot reject homogeneity of labor. Frisvold (1994) explores labor heterogeneity, again using Indian household survey data. The author's primary motivations are to explore supervisory costs and how they affect farm activity, but he also examines the question of labor heterogeneity. Using a similar specification to Bardhan (1973), Frisvold (1994) rejects labor homogeneity and finds that family supervision labor augments hired labor.

Bardhan (1973) and Frisvold (1994) both estimate a production function similar to:

$$\ln q = \ln \alpha_0 + \alpha_1 \ln A + \alpha_2 \ln V + \alpha_3 \ln L + \theta \ln RATIO + \delta_1 SOIL_1 +$$

$$\delta_2 HYV + \sum_{k=3}^{n} \delta_k Z_k + u \quad (2)$$

where L is total labor (F+H) labor services functions of the following form:

$$E = (F + H) \left[\frac{F}{F + H} \right]^{\gamma} \quad (3)$$

in log form:

$$\log(E) = \log(F + H) + \gamma \cdot \log \left(\frac{F}{F + H} \right) \quad (4)$$

Following the similar or same specification in Frisvold (1994) E represents effective total labor, A is area planted, V is the value of manure, fertilizers, and feed, F is family labor, H is hired labor. $RATIO$ is the ratio of family/total labor, and SOIL is a set of dummies for soil type, while HYV is a dummy that takes one if the farmer planted a high-yielding variety. γ, which is represented by θ in equation 1, can then be estimated by OLS. If family and hired labor are perfect substitutes, I can test $\gamma = 0$. Unfortunately the data available to me do not include the same type of detailed information about supervisory labor that are available for Frisvold (1994), so further analysis of supervision of hired labor is left to future research.

2.2.2 Deolalikar and Vijverberg tests

Deolalikar et al. (1987) use a generalized quadratic labor services function to test for the effects of labor heterogeneity using Indian and Malaysian data. Importantly they separate two aspects:

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(a) perfect substitutability, and (b) a quality differential between family and hired labor. They outline in their article the implications for labor heterogeneity between hired and family labor; if the two are substitutes, the authors argue, and family members migrate away from the village farms, this will raise the wages of hired labor. They add that in the case that the two are not at all substitutable, an outmigration of family labor could actually decrease demand for hired labor. This makes sense particularly when hired labor markets are illiquid or incomplete. In contrast to Tanzania, India and Malaysia have or had active agricultural labor markets, with most farms hiring in some labor. In Tanzania, on the other hand, a smaller percentage of farms, 43% in my sample, hire-in labor and the total number of hired days is very low. Deolalikar et al. (1987) reject perfect substitutability between family and hired labor in both India and Malaysia. They also find that hired labor is more efficient in terms of output than family labor using the ratio of marginal productivities.

Following the specification of their paper, a Cobb-Douglas form is estimated, and a generalized quadratic form is used to characterize the labor services function. The reason for using the quadratic form nested in a Cobb-Douglas is that, by contrast, in Cobb-Douglas the marginal product of all inputs goes to infinity as as the input goes to zero. Using the quadratic form will allow for slightly more flexibility than Benjamin (1992), as I would like to consider explicitly the nature of the substitution of hired and family labor.

$$lnY = lnC + \beta_1 lnL + \beta_2 lnA + \Sigma_i \beta_i lnX_i + \varepsilon \tag{5}$$

in the above equation, Y is output, and labor services L , A represents services from land, and $X_i =$ quantity of input i. Continuing in the format of Deolalikar et al. (1987), I assume that labor services are produced using family labor and hired labor by the generalized quadratic function:

$$L = \alpha_1 L_f + (1 - \alpha_1)L_h + \delta_{11}L_f^2 + \delta_{22}L_h^2 + \delta_{12}L_h \cdot L_f \tag{6}$$

This form is flexible enough to allow various elasticities of substitution between family and hired labor (Deolalikar et al., 1987). In order for equation (4) to be concave, equation (5) must also be concave, a necessary condition is that δ_{11} and δ_{22} are not positive. Furthermore, α_1 and

$(1 - \alpha_1)$ must be positive. Following Deolalikar et al. (1987), the appropriate test is then an likelihood ratio (LR) test that $\delta_{11} = \delta_{22} = \delta_{12} = 0$, which is a direct test of the hypothesis of perfect substitutability between labor types. If the two types of labor are equivalent, $\alpha_1 = 0.5$, then equations (4) and (5) simplify to a standard Cobb-Douglas form:

$$L = \alpha_1 L_f + (1 - \alpha_1)L_h \tag{7}$$

Note that, in the case where $\delta_{11} = \delta_{22} = \delta_{12} = 0$, and we are in a Cobb-Douglass universe, the marginal product of labor is given in full by $\beta_1 \cdot \alpha_1 L_f$ and $\beta_1 \cdot (1 - \alpha_1)L_h$ and we have:

$$lnY = lnC + \beta_1\alpha_1 lnL_f + \beta_1(1 - \alpha_1)lnL_h + \beta_2 lnA + \Sigma_i\beta_i lnX_i + \varepsilon \tag{8}$$

2.2.3 Fertilizer Factor Allocation

A final strategy I employ in understanding Tanzanian agricultural households is to analyze intensity of input use in the form of organic fertilizer. Organic fertilizer is much more abundant and accessible in Tanzania than chemical fertilizers, as organic fertilizer is simply an output from livestock kept by many farms. Similar to Gavian and Fafchamps (1996), I regress organic fertilizer use per acre on household and plot characteristics. Organic fertilizer is considered a short term investment since it's benefits may last longer than one cropping season (Gavian and Fafchamps, 1996). If markets for organic fertilizer inputs are functioning and complete, returns to fertilizer should be equalized across all plots conditional on plot characteristics, crop choice, and weather. Although organic fertilizer is too bulky to transport, at least in the West African context overnight paddocking contracts have been documented. Gavian and Fafchamps (1996) find that land holdings per household member negatively influenced organic fertilizer use per hectare, and that organic fertilizer use was largely determined by the size of the livestock holdings of the household.
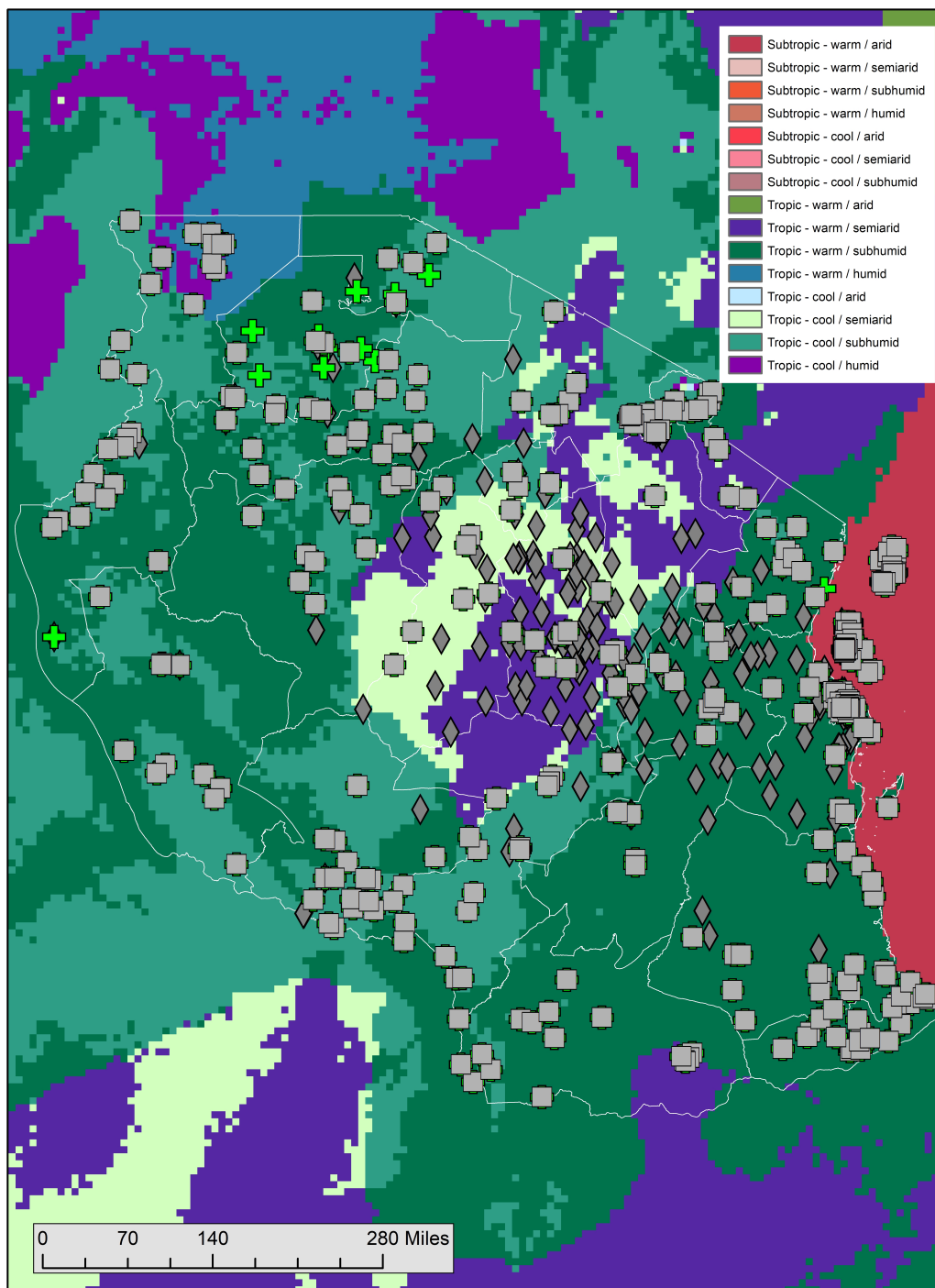
Figure 1: Survey Households Overlayed on Tanzanian Agricultural Ecological Zones; Source: Tanzania LSMS, IFPRI Raster Data; http://www.IFPRI.org

The legend of the map shows the following Agricultural Ecological Zones:
- Subtropic - warm / arid
- Subtropic - warm / semiarid
- Subtropic - warm / subhumid
- Subtropic - warm / humid
- Subtropic - cool / arid
- Subtropic - cool / semiarid
- Subtropic - cool / subhumid
- Tropic - warm / arid
- Tropic - warm / semiarid
- Tropic - warm / subhumid
- Tropic - warm / humid
- Tropic - cool / arid
- Tropic - cool / semiarid
- Tropic - cool / subhumid
- Tropic - cool / humid

The scale shows 0, 70, 140, 280 Miles.

Long Rainy Season		Short Rainy Season	
Variable	Acres Planted	Variable	Acres Planted
Maize	19701	Maize	4211
Paddy	4346	Beans	1528
Beans	4161	Groundnut (Peanut)	579
Groundnut (Peanut)	3791	Sweet Potatoes	453
Sorghum	2503	Paddy	434
Cotton	2128	Cotton	416
Sweet Potatoes	2036	Cowpeas	259
Sunflower	1738	Green Gram	217
Cowpeas	1409	Sorghum	203
Pigeon Pea	1361	Cocoyams	113
Sesame	923		
Green gram	892		
Tobacco	692		
Bulrush MIllet	645		
Chickpeas	548		
Bambara Nuts	496		
Cassava	334		
Cocoyams	298		
Finger millet	282		
Pumpkins	267		
Irish Potatoes	179		
Kiwi	161		
Tomatoes	148		
Cashewnut	102		

Table 1: Area Planted by Crop in Tanzania During the Survey Period

3   The Setting and the Data

Tanzania as a country is well-suited for agricultural production, and farming makes up a substantial portion of the activity of low-income households: 37% of men in the survey worked on their own farm last week, and 39% for women. Tanzania straddles several agro-ecological zones; in the north around Lake Victoria and in the south-western part of Tanzania there are cool sub-humid tropic climates. Much of the southern and eastern as well as south-eastern parts of Tanzania are warm sub-humid tropical climate, while a large central swath of Tanzania is characterized by a warm and cool semi-arid tropical climate. The dataset used in this paper is nationally representative, meaning all of these zones are included in the analysis. This is an important dimension of heterogeneity within the data, and it is one of the reasons for the inclusion of specific types of fixed effects. Principal crops grown in Tanzania include maize, rice, sweet potatoes, cassava, and sorghum among others. Agriculture and livestock make up a substantial part of Tanzanian economic activity, with those outside of the agricultural business mostly engaged in teaching, civil service, or natural resource extraction.

The primary data used are from the World Bank's Living Standards Measurement Survey (LSMS) instrument from Tanzania, which includes a substantial agricultural component captured over four waves from 2008-2015. All waves of data are freely available from several sources including the World Bank website and the website of the Tanzanian National Bureau of Statistics. Data were collected on basic household demographic characteristics, and the questionnaire included modules on labor, consumption, assets, and anthropometric data for household members. Agricultural data were recorded separately, but at the same sitting for the two agricultural seasons experienced in some parts of Tanzania. For the two separate seasons, locally referred to as the 'short rainy' season and the 'long rainy' season, plot inputs and are recorded as one observation per year, though outputs are recorded separately and summed across seasons for our analysis.

An important feature of this dataset is that records kept at the plot level are highly detailed. Included are information on plot ownership, seed type and purchases, fertilizer use, which household member manages the plot, as well as which family members provide labor on the plot and whether or not any hired labor was used. Descriptive statistics for household demographic characteristics as well as farm assets and other characteristics can be found in Table 10 in the

Table 2: Household Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
# of HH Mems.	10,326	5.52	3.14	1	55
# Married Mems.	10,326	3.46	1.98	1	31
# Children	10,326	2.03	1.81	0	26
# Adult Mems.	10,326	3.08	1.89	0	29
# Adult Men	10,326	1.49	1.19	0	13
# Adult Women	10,326	1.59	1.10	0	16
# Seniors	10,326	.27	.54	0	3
HH Avg. Age	10,326	26	14	7	92
Avg. Adult Educ	10,014	4.17	2.82	0	20
Avg. Adult Age	10,014	31.10	8.47	13	64
HH Head Married	10,326	.48	.50	0	1
Age HH Head	10,326	38.77	23.70	0	108
HH Head Years Educ	10,326	3.23	4.02	0	22
Gender HH Head	10,326	.17	.38	0	1
Farm Acres	10,326	36.38	155.25	.005	6885.9
HH Assets	10,326	8707460	996000000	0	5910000000

appendix.

Wave 1 of the survey was collected from September 2008 and the bulk of interviews were completed by September of the following year. The sample contains 3,265 households, including 16,709 individuals, with a median of 5 members per household. There were 5,126 plots held by 2,284 households, 4,934 (96%)of which were planted, and 81 percent of households in the sample held agricultural land. The median number of plots in the 2008-09 survey wave is 2.5 plots per (planted) agricultural household with an median overall land area of 2.5 (s.d.=11)) acres. The household head has an median age of 43, whereas the median household age is only 22.3, quite a large gap. The average adult (12-65) in a household has 5 years of schooling, and is 34 years of age. Households have a median of 2 children, 2 adult members, and a median of 0 senior members. Wave 2 was collected from October 2010 with the majority of interviews completed by September 2011. The second wave sample contains 3,924 households, including 20,559 individuals with a median of 5 members per household. Included are 3,168 round one households, a re-interview rate of 97 percent. Households with agricultural land represent 2,630 households (67 percent) in the survey, and there are a total of 3,829 planted plots, with a median of 2 plots per agricultural household and an average farm size of 2.8 (s.d.=10) acres. Collection for wave 3 began in October of 2012 with interviews nearly complete by the end of October 2013. The 3rd wave of the sample is expanded, and includes 5,010 households and 25,412 individuals with a median of 6 members per household. The households who held agricultural land were 3,300 (65 percent) with a total of 4,934 usable plots, a median of 2 plots per farm

	Has Farm	No Farm
Table 3: Labor Activities		
Pct. of Sample	66.4	33.6
Male member earning wage off-farm	14.7	1.9
Female member earning wage off-farm	12.6	1.4
Male member in off-farm ag employment	62.9	45.8
Female member in off-farm ag employment	66.7	37.8
Male member in non-farm nonag employment	63.4	66.6
Female member in non-farm nonag employment	63.8	46.3
Male member working on own farm	37.0	3.5
Female member working on own farm	39.8	3.3
Unemployed member in HH	36.2	38.4
Male Labor Force Participation Rate	50.6	57.2
Female Labor Force Participation Rate	49.4	42.8
Pct of Male Labor Force Earning Wage	24.3	58.3
Pct of Female Labor Force Earning Wage	12.1	37.3
Unemployment Rate	13.4	20.2

Table 4: Labor Use on Farms in Sample

Labor Type	Pct Used	Mean total labor-days	Median total labor-days	Pct. Hired	Mean hired labor-days	Median hired labor-days	Mean Total Labor-Days per Acre	Median Total Labor-Days per Acre	Mean Total Labor-Days per Hect	Median Total Labor-Days per Hect	Mean Hired Labor-Days per Acre	Median Hired Labor-Days per Acre	Mean Wage	Median Wage
Planting	0.99	121.9 (847.6)	57.5	0.34	2.1 20.0	0	47.2 62.9	21.6	116.5 155.4	53.3	2.1 5.0	0	6,646 9,043	2,857
Weeding	0.88	94.13 999.7	8	0.28	8.1 73.3	0	28.1 46.0	9.1	69.4 113.6	22.6	1.1 3.2	0	12,126 16,276	4,000
Harvesting	0.96	43.07 314.5	14	0.19	6.2 73.8	0	16.8 20.4	8.9	38.6 48.9	19.8	0.6 1.4	0	3,604 3,153	2,500

household with an average farm size of 3 (s.d.=15.7) acres. The fourth wave of the survey sampled the same villages, but replaced the households in the sample. The interviews began in October 2014 and were completed by August 2015. It includes 3,352 households and 16,285 individuals. The median number of household members remains 6. The agricultural modules contains data on 4,291 plots with the average farm size being 3.4 (s.d.=16) acres. The median number of plots planted per agricultural household is 2.

Descriptive Table 3 shows both family and hired labor use at the plot level. Labor is split into planting, weeding, and harvesting periods, though in the analysis planting+weeding activities are summed to simplify and because this is supported by the literature on observability of agricultural activities. Family labor use is much higher than hired labor use on average. Average hired labor use in both the preparatory and harvest periods appears to be very stable across all waves.

3.1 LandScan Data

LandScan gridded population data is a set of gridded population estimates, available on an annual basis, with a fine resolution allowing analysis at a more dis-aggregated level. The benefit of using these data are that they allow us to capture fluctuations in population that might be otherwise difficult to observe, and where we can be mostly sure the measurement error of NTL is orthogonal to our other controls. In Tanzania, I am not aware of any data covering the entirety of the country on an annualized basis to measure population. As such the LandScan data will be a great benefit, and they will also help us identify the effects of population changes on household economic activities. These data originate from the OakRidge National Laboratory (ORNL), which is a research institution funded by the US Department of Energy, and managed in partnership with the University of Tennessee. The estimates are generated by an algorithm that takes as its primary inputs high resolution, proprietary daytime imagery (Rose and Bright, 2014). The following brief description comes from the ORNL-LandScan documentation, "the modeling process uses sub-national level census counts for each country and primary geospatial input or ancillary datasets, including land cover, roads, slope, urban areas, village locations, and high resolution imagery analysis; all of which are key indicators of population distribution."[1]

4 Results

4.1 Tests for Labor Heterogeneity

4.1.1 Wage Differential

The dataset has wage data from both contract workers hired in to work on the farm and from the labor module on wages paid to family members who work on other farms or in agricultural sector jobs. Family agricultural wages were scaled to a daily wage, and then standardized by removing the most extreme values before being collapsed to the village level median wage. The same process was applied to the wages of hired-in labor. The raw data are also processed to remove extreme values, and the data are collapsed to their median values. I then ran the simple regression of family wages on hired wages. If there is no relationship, the coefficient on hired

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[1]https://landscan.ornl.gov/documentation/#inputData

VARIABLES	ag wage	ag wage
hired wage	0.0265	
	(0.0406)	
harv wage		0.0150
		(0.0341)
Observations	740	740
R-squared	0.004	0.004
Wave FE	yes	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regressions of Wage Differentials

wages should be equal to zero. Looking at Table 4, we can see a normal linear regression of family wage on hired wage reveals no relationship which is significant at standard levels.

4.1.2 Bardhan-Frisvold Test for Labor Homogeneity

The next test I run to examine the relationship between hired and family labor is based on those used in papers by authors Pranab Bardhan (1973) and George Frisvold (1994), but adapted to include indicator variables for irrigation status and land tenancy. Unlike in previous works, I choose to preparatory period and harvest period labor into separate categories for analysis. The following expression can then estimated by ordinary least squares (OLS):

$$\ln q = \ln \alpha_0 + \alpha_1 \ln A + \alpha_2 \ln V + \alpha_3 \ln L_{prep} + \alpha_4 \ln L_{harv} +$$

$$\theta_1 \ln RATIO_{prep} + \theta_2 \ln RATIO_{harv} + \delta_k \Sigma_{k=1}^K SOIL_k +$$

$$\psi_1 HYV + \psi_2 FERT + \psi_3 IRR + \psi_4 RENT + u \quad (9)$$

This is a production function estimation. In this case I estimate non-tree crops and tree crops separately. Descriptive statistics for the variables used in the regressions can be found in Table 5, and the results can be found in Table 6. IRR is a dummy variable that takes 1 if a plot is irrigated, 0 otherwise, HYV is an indicator if the farmer is growing a high-yielding variety, $SOIL$ is a set of indicator dummies for soil type, $FERT$ is the quantity of fertilizer applied, and $RENT$ is a dummy variable designating the plot as rented or not rented, while the terms $RATIO_{prep}$ and $RATIO_{harv}$ are the main variables of interest. These ratios represent

VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
irrigated	327	1	0	1	1
organic_fert	1,655	902.4	1,981	2	32,000
rented_in	735	1	0	1	1
area_planted	12,410	3.722	12.39	0.0047	868
improved_seeds	6,081	1	0	1	1
plot_expense	8,238	82,649	252,522	2	7.61E+06
num_trees	6,152	157.1	781.9	1	30,700
total_prep_labor	14,840	64.28	65.52	1	977
Ratio Prep	14,564	48.81	59.03	0.016	941
total_harv_labor	14,056	27.86	40.25	0.5	729.5
Ratio Harvest	13,903	24.36	37.35	0.000269	730.5

Table 6: Descriptive Stats of Variables Used in Bardhan-Frisvold Tests for Labor Homogeneity

the expression defined earlier in (2) and (3), and the coefficient of these ratios corresponds to the expression $\theta = \alpha_3 \gamma$, where $L_j = (F + 1)/L$. Therefore a test of $\theta = 0$ is a test for the substitutability of labor. Columns 1 and 2 of Table 6 are the pooled OLS estimates using the full sample of data, and including wave dummies to capture variation common to the entire sample in each of the 4 waves. Column 1 represents the plots planted to perennial (ground-cover) crops, and column 2 represents tree crops. Columns 3 and 4 are the same pair of regressions, this time using a within-village transformation to remove village-specific effects. All coefficients therefore represent the deviations from village-specific means. The final columns (5) and (6) are the same regression this time using within-household transformations.

We can see the pattern of rejections looking across the column of ratio_1. For perennial crops, the coefficient is not rejected in any specification. For the tree crops, however, the coefficient on the preparatory labor ratio of family to total labor, an increase in the amount of family labor relative to hired labor results in an increase in output. We can interpret this as meaning that in the case of tree prep labor, family labor is more productive than hired, while I cannot reject differences between family and hired labor in the preparatory period for perennial crops. With respect to the harvest period the ratio_2 variable is the variable of interest. In all cases except for the household-level fixed effect specification, the variable is significant and negative, meaning a higher ratio of family to total labor decreases overall productivity. This is consistent with the results of the Deolalikar-Vijverberg tests as well.

Table 7: Bardhan-Frisvold Tests for Labor Homogeneity

	(1) BF Test Crops	(2) BF Test Crops	(3) BF Test Tree Crops	(4) BF Test Tree Crops
# Trees			0.234***	0.319***
			(0.0115)	(0.0229)
Area Planted	0.754***	0.655***		
	(0.0268)	(0.0419)		
Total Prep Labor	-0.115***	-0.0575	0.123***	0.0936**
	(0.0320)	(0.0419)	(0.0329)	(0.0401)
Total Harv Labor	0.348***	0.297***	0.310***	0.183***
	(0.0305)	(0.0409)	(0.0350)	(0.0397)
Plot Expenditure	0.0255***	0.0184***	0.0497***	0.0383***
	(0.00466)	(0.00656)	(0.00457)	(0.00616)
Ratio_{prep}	0.0154	0.00250	0.0476*	0.0502*
	(0.0214)	(0.0289)	(0.0252)	(0.0293)
Ratio_{harv}	-0.0487**	-0.0254	-0.135***	-0.0324
	(0.0218)	(0.0299)	(0.0309)	(0.0352)
kg org. fert.	0.0570***	0.0574***	0.0553***	0.0187
	(0.00871)	(0.0131)	(0.00878)	(0.0141)
Plot Irrigated	0.398***	0.544***	0.406***	0.0550
	(0.108)	(0.203)	(0.128)	(0.213)
Plot Rented In	-0.0921	-0.219*	0.216	0.129
	(0.0744)	(0.118)	(0.245)	(0.478)
Observations	5,330	5,330	5,349	5,349
R-squared	0.264	0.184	0.223	0.164
Number of HH		2,235		1,939

Cluster-Robust standard errors (HH level) in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Deolalikar-Vijverberg Test - NLLS Estimates Prep Period

VARIABLES	b0	α_1	δ_{11}	δ_{22}	δ_{12}
	13.22***	0.424***	0.00326***	0.000859***	0.0141***
	(0.172)	(0.00131)	(0.000107)	(1.24e-05)	(0.000136)
Observations			25,467		
R-squared			0.870		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Deolalikar-Vijverberg Test - NLLS Estimates Harvest Period

VARIABLES	b0	α_1	δ_{11}	δ_{22}	δ_{12}
	3.013***	0.461***	-0.00153***	0.000781***	0.0236***
	(0.0582)	(0.00150)	(0.000174)	(2.27e-05)	(0.000281)
Observations			25,467		
R-squared			0.809		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.1.3 Deolalikar and Vijverberg Generalized Quadratic NLLS Estimates

In the case of this dataset I chose to estimate preparatory labor (any labor that occurs pre-harvest including planting, weeding, and fertilizing activity) and harvest labor separately. This is in contrast with the original authors who estimate all farm labor together, with the only distinction being between family and hired labor. The first test is a likelihood ratio test of the model from equation 5: $\delta_{11} = \delta_{22} = \delta_{12} = 0$. The test for the preparatory labor period rejects with $\lambda_3 = 28672.14$, and $\lambda_3 = 12929.81$ which are both significant at the .1% level. This means that in both the harvest period and the preparatory labor period I can reject perfect substitutability between hired labor and family labor. I perform the likelihood ratio tests then for the perfect substitutability of labor from equation 6, $\delta_{11} = \delta_{22} = \delta_{12} = 0; \alpha_1 = 0.5$ and in both cases, homogeneity of labor is rejected: $\lambda_4 = 52043.73$ for the preparatory period, and $\lambda_4 = 42101.23$.

Next I present the full results from the nonlinear least squares estimates of the parameters in expression (4). The estimates for α_1 are 0.424 for the preparatory season, and $\alpha_1 = 0.461$ in the harvest labor season. This indicates that family labor increases to be more productive during the harvest labor period, and that the ratio of the marginal productivities $(\alpha_1/1 - \alpha_1)$

is larger in the harvest season, 0.74 (prep) compared to 0.86 (harv). This ratio being closer to unity indicates higher/greater substitutability. This is slightly lower than but comparable to 0.78 for Malaysia, and quite far off from the estimated 0.32 for Matar Taluka (India) in Deolalikar et al. (1987).

As we can see, the preceding exercise has indicated that hired and family are not perfect substitutes, neither in the preparatory period, nor in the harvest period. The harvest period estimates indicate that the marginal product of family labor is positive but decreasing, significant at the 0.1% level. The coefficient on the interaction term is also positive, which could be interpreted as signifying that increased supervision costs improve the performance of hired labor.

4.2 Plot-level Labor Demand Estimates

I now turn my attention to focus on the tests of the separation hypothesis. Based on the results of the earlier analysis, family labor and hired labor are estimated separately here, as are pre-harvest (preparatory) labor and harvest labor. A household fixed effect is included, as well as a village-wave dummy to capture price or rainfall variation at the village level. Table 9 displays the results of the OLS and FE-within transform estimations of family preparatory and harvest labor demand at the plot level. Table 10 shows the results of regressing the log number of hired labor days on the same set of control variables. The columns in table 10 also correspond to pooled OLS and within-household fixed effects estimates.

4.2.1 Family Labor Estimates

Turning to Table 9, the first three columns, 1-3, represent the regression of family *preparatory* labor on the set of plot, household, and environmental control variables described above while columns 3-6 represent family *harvest* labor. The first column represents the pooled OLS estimates of the full sample with village-wave fixed effects only. The second column is also pooled OLS estimates, this time restricted to the same sample used in the household fixed effects regressions in columns 3 and 6. All columns contain village-wave fixed effect dummy variables, which control for things like village-specific weather and price shocks. Note that all regressions also contain controls for soil type and for the slope or gradient of the plot.

Starting with the family labor in Table 9. The first half of the table shows mostly the

plot-level control variables. We can see that labor days in all categories are increasing with the size of the plot, which is an indication that households are able to vary their labor supply to meet plot-level demands. In all columns, plot labor is increasing with plot expenditure. Expenditure includes items like seeds and total wages expended on hired labor. Irrigated plots receive more labor, though a plot becoming irrigated leads to a decline in family harvest labor. Organic fertilizer increases labor use in all columns but columns 2, 4, and 5. Intercropped plots, plots planted to more than a single crop, appear to demand higher levels of preparatory labor, though they require less harvest labor. Improved seeds also decrease the amount of family harvest labor applied.

Recall from the theoretical section that any t-test for the significance of a coefficient on household-level variables signifies a rejection of completeness and/or separation meaning that household characteristics are influencing plot-level production decisions. The proceeding variables in the analysis have been all plot-level covariates. Any variable from this point forward in the analysis constitutes a potential exclusion restriction. The log of area planted on all other plots is significant and negative for family preparatory labor, implying constraints to labor use in the preparatory season. An increase in the farmer-estimated value of the plot, considered here a proxy for plot quality, also increases labor across all columns.

Turning to the managerial human capital variables, we see that the plot having exclusively female managers results in a large reduction in the amount of labor, relative to plots which are managed by only males, and the same is true as well for mixed gender plots. Those also receive less labor, with the estimates significant at the .01% significance level. Average age of the managers increases the family labor demanded in both preparatory and harvest periods. If we consider average age of the manager is likely to proxy very well for experience, this makes a lot of sense. The indicator variable for the manager being also the head of the household has a negative effect on labor demand in both prep and harvest periods, most likely because the head of the household has many demands on his or her time.

Next are the principal variables of interest, the variables indicating total family size in different categories. As we see, one additional member in the adult category leads to an increase in labor days, with the effects statistically significant at the highest significance levels. Harvest and prep labor days also appear to be increasing in the number of children, and decreasing in the number of senior household members, consistent with expectations. Family labor use,

both preparatory and harvest labor, is decreasing in the log of population density as measured by LandScan data, though the effect is not identified using the Within-HH estimates. Family labor is also decreasing in the log of total household assets, indicating agricultural work may be perceived as "inferior" labor.

Next are several control variables for the demographics of the household head. The age of the household head has a negative effect on the amount of labor demanded at the plot level, as does education, with both effects identified in POLS model but only the age of the head being identified by the within-FE model.

Table 10: Plot-level Family Labor Demand

VARIABLES	(1) prep_labor	(2) prep_labor	(3) prep_labor	(4) harv_labor	(5) harv_labor	(6) harv_labor
Area Planted	0.544***	0.502***	0.449***	0.469***	0.431***	0.347***
	(0.0123)	(0.0149)	(0.0232)	(0.0137)	(0.0169)	(0.0246)
Plot Expense	-0.00750***	-0.0118***	0.00771***	0.00518***	0.00585***	0.0161***
	(0.00168)	(0.00198)	(0.00237)	(0.00182)	(0.00220)	(0.00274)
Collective	0.451***	0.406***	0.386***	0.337***	0.308***	0.324***
	(0.0482)	(0.0544)	(0.0771)	(0.0523)	(0.0597)	(0.0940)
Plot is rented	0.0728**	0.0490	0.142***	0.0150	-0.0211	0.0287
	(0.0347)	(0.0391)	(0.0452)	(0.0389)	(0.0438)	(0.0526)
Irrigated	0.192***	0.229***	0.00542	0.139***	0.224***	-0.241***
	(0.0465)	(0.0549)	(0.0716)	(0.0497)	(0.0595)	(0.0866)
Kg of Manure	0.0114***	0.00879*	0.0298***	0.00390	0.00156	0.0134**
	(0.00382)	(0.00457)	(0.00521)	(0.00448)	(0.00546)	(0.00623)
Intercropped	0.0348**	-0.0261	-0.0158	-0.0957***	-0.159***	-0.124***
	(0.0167)	(0.0192)	(0.0216)	(0.0185)	(0.0217)	(0.0256)
Imp Seed Use	-0.00768	0.00538	-0.00750	-0.0758***	-0.0861***	-0.0823***
	(0.0183)	(0.0227)	(0.0260)	(0.0205)	(0.0262)	(0.0300)
Distance to Household	0.00664***	0.00729***	0.0172***	-0.000508	0.00290	0.0102***
	(0.00183)	(0.00223)	(0.00284)	(0.00189)	(0.00241)	(0.00293)
Area Planted other plots	-0.0755***	-0.0948***	-0.0923***	0.0196**	0.0148	-0.0120
	(0.00912)	(0.0110)	(0.0203)	(0.00983)	(0.0123)	(0.0218)
Plot estimated value	0.00935***	0.0207***	0.0342***	0.00779***	0.0133***	0.0427***
	(0.00256)	(0.00295)	(0.00597)	(0.00258)	(0.00302)	(0.00659)
Estimated value of all other plots	-0.000637	0.000582	-0.00577*	-0.00282	-0.00134	-0.00375
	(0.00161)	(0.00194)	(0.00318)	(0.00172)	(0.00218)	(0.00371)
Observations	24,039	17,088	17,088	24,039	17,088	17,088
R-squared	0.695	0.705	0.647	0.502	0.492	0.400
Number of households			3,917			3,917
Soil Controls & Slope controls	yes	yes	yes	yes	yes	yes
HH FE			yes			yes
Village-Wave FE	yes	yes	yes	yes	yes	yes

Cluster-Robust standard errors in parentheses

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

4.2.2 Hired Labor Estimates

Turning to the hired labor demand estimates in Table 10, we see that, although hired labor use is quite low in terms of the intensity, it is increasing with area planted, and increasing with area planted to other plots, though that effect is only identified in the POLS regressions and not by the within-FE model. Recall that column 1 and 3 represent the POLS estimates using village-wave fixed effects, while columns 2 and 4 represent the same, restricting the sample to the same sample used in the household fixed effects estimations in columns 3 and 6. Columns 3 and 6 are therefore the most aggressive and robust estimations. Collective plots receive less hired labor than individually-managed plots, and rented plots receive less hired labor as well, possibly because farmers who rent are poorer, though household assets have been controlled for.

Organic fertilizer has a decreasing effect on hired labor, possibly indicating the two are rough substitutes. Interestingly increases in the value of the plot, possibly caused by increases in the soil quality, increase the amount of hired harvest labor in the case of the FE-within model in column 6. This stands in contrast with the above findings about organic fertilizer. Interestingly, improved seeds also decrease hired labor, possibly because the two are being substituted by farmers facing capital constraints.

Most importantly, the number of adult members *decreases* the amount of hired labor. This means I can unequivocally reject separation with respect to hired labor inputs.

Hired labor is increasing in the log of population density as well, but only for preparatory hired labor, and only using the POLS model in columns 1 and 2. Hired labor is also increasing in household assets, which is another rejection of the separation hypothesis, though there does not appear to be enough variation in household asset values to identify the effects beyond the 10% level for the fixed-effects within model in columns two and four.

Table 9: Plot-level Family Labor Demand

VARIABLES	(1) prep_labor	(2) prep_labor	(3) prep_labor	(4) harv_labor	(5) harv_labor	(6) harv_labor
All female mgrs	-0.165***	-0.232***	-0.193***	-0.167***	-0.253***	-0.234***
	(0.0319)	(0.0372)	(0.0607)	(0.0336)	(0.0407)	(0.0668)
Mixed-gender mgrs	-0.212***	-0.226***	-0.197**	-0.205***	-0.235***	-0.260***
	(0.0501)	(0.0567)	(0.0800)	(0.0545)	(0.0625)	(0.0982)
Avg. Educ of mgrs	-0.00521	-0.0153	0.0150	0.0268**	0.0298**	0.0465*
	(0.0119)	(0.0139)	(0.0223)	(0.0124)	(0.0150)	(0.0252)
Avg. Age of mgrs	0.919***	0.906***	0.854***	0.608***	0.589***	0.576***
	(0.0183)	(0.0232)	(0.0358)	(0.0181)	(0.0236)	(0.0357)
Avg. BMI of mgrs	0.00713	0.0359**	0.0426*	-0.00190	0.0170	0.0123
	(0.00850)	(0.0180)	(0.0254)	(0.00946)	(0.0190)	(0.0271)
Mgr is head	-0.132***	-0.131***	-0.191***	-0.0834*	-0.0562	-0.108
	(0.0445)	(0.0494)	(0.0729)	(0.0446)	(0.0519)	(0.0758)
Children in HH	0.0322***	0.0292***	0.0156	0.0368***	0.0349***	0.0107
	(0.00407)	(0.00479)	(0.0131)	(0.00455)	(0.00557)	(0.0153)
Adults in HH	0.0618***	0.0637***	0.0780***	0.0586***	0.0659***	0.0839***
	(0.00455)	(0.00542)	(0.0131)	(0.00487)	(0.00598)	(0.0146)
Seniors in HH	-0.0476***	-0.0335*	0.0793*	-0.0481***	-0.0260	0.0371
	(0.0161)	(0.0187)	(0.0472)	(0.0172)	(0.0206)	(0.0554)
Population density	-0.0323***	-0.0336***	-0.00301	-0.0262***	-0.0275***	0.0200*
	(0.00445)	(0.00448)	(0.00985)	(0.00497)	(0.00500)	(0.0114)
Total HH Assets	-0.0618***	-0.0596***	-0.0278***	-0.0395***	-0.0459***	-0.0262**
	(0.00530)	(0.00670)	(0.00993)	(0.00531)	(0.00743)	(0.0112)
Total Farm Assets	0.00516	-0.00178	-0.00787	0.0178**	0.0123	0.00510
	(0.00785)	(0.00918)	(0.0153)	(0.00819)	(0.0109)	(0.0179)
Total Animal Units	-0.0649***	-0.120***	0.148***	-0.00645	-0.0367	0.153***
	(0.0177)	(0.0214)	(0.0524)	(0.0193)	(0.0237)	(0.0583)
Age of the HH Head	-0.397***	-0.380***	-0.528***	-0.252***	-0.279***	-0.331***
	(0.0303)	(0.0356)	(0.119)	(0.0312)	(0.0376)	(0.126)
Yr of Educ of HH Head	-0.0449***	-0.0294**	0.0172	-0.0386***	-0.0339***	-0.0596**
	(0.00984)	(0.0115)	(0.0298)	(0.00998)	(0.0119)	(0.0296)
Gender of HH Head	-0.0904***	-0.0863***	-0.174**	-0.0338	-0.0599**	-0.0666
	(0.0227)	(0.0273)	(0.0835)	(0.0236)	(0.0286)	(0.0985)
HH had a death	-0.0379	-0.0189	-0.0423	0.0441	0.0276	0.00608
	(0.0326)	(0.0358)	(0.0619)	(0.0345)	(0.0390)	(0.0663)
Agricultural wage	-0.00169	-0.00980	0.00800	-0.0229***	-0.0249***	-0.0174
	(0.00619)	(0.00642)	(0.0107)	(0.00696)	(0.00737)	(0.0135)
Observations	24,039	17,088	17,088	24,039	17,088	17,088
R-squared	0.695	0.705	0.647	0.502	0.492	0.400
Number of households			3,917			3,917
Soil & Slope controls	yes	yes	yes	yes	yes	yes
HH FE			yes			yes
Village-Wave FE	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Plot-level Hired Labor Demand

VARIABLES	(1) hired_prep_labor	(2) hired_prep_labor	(3) hired_prep_labor	(4) hired_harv_labor	(5) hired_harv_labor	(6) hired_harv_labor
Area planted	0.228***	0.208***	0.180***	0.194***	0.173***	0.159***
	(0.0126)	(0.0152)	(0.0202)	(0.0105)	(0.0125)	(0.0167)
Plot expense	0.115***	0.120***	0.115***	0.0526***	0.0507***	0.0462***
	(0.00158)	(0.00194)	(0.00292)	(0.00125)	(0.00152)	(0.00210)
Collective plot	-0.116***	-0.144***	-0.0854	-0.0668**	-0.0414	0.000268
	(0.0421)	(0.0463)	(0.0608)	(0.0320)	(0.0355)	(0.0506)
Plot is rented	-0.456***	-0.517***	-0.520***	-0.154***	-0.141***	-0.168***
	(0.0416)	(0.0479)	(0.0571)	(0.0330)	(0.0386)	(0.0470)
Irrigated	-0.00497	-0.0536	-0.00816	-0.122***	-0.164***	-0.0788
	(0.0491)	(0.0603)	(0.0878)	(0.0409)	(0.0498)	(0.0694)
Kg of manure	-0.0177***	-0.0234***	-0.0246***	-0.0102***	-0.00702*	-0.00675
	(0.00442)	(0.00532)	(0.00568)	(0.00352)	(0.00415)	(0.00549)
Intercropped	-0.132***	-0.125***	-0.0633***	-0.141***	-0.116***	-0.0794***
	(0.0169)	(0.0194)	(0.0214)	(0.0133)	(0.0152)	(0.0175)
Improved seeds	-0.266***	-0.288***	-0.234***	-0.101***	-0.0926***	-0.0737***
	(0.0186)	(0.0223)	(0.0245)	(0.0144)	(0.0171)	(0.0197)
Distance to Household	0.0206***	0.0217***	0.0171***	0.0124***	0.0109***	0.00842***
	(0.00173)	(0.00212)	(0.00267)	(0.00139)	(0.00168)	(0.00198)
Area planted other plots	0.0284***	0.0247**	0.0196	0.0315***	0.0231***	0.0175
	(0.00828)	(0.0103)	(0.0185)	(0.00667)	(0.00832)	(0.0148)
Plot est. value	0.00244	0.00126	0.0101**	0.00239	0.00304*	0.0125***
	(0.00208)	(0.00237)	(0.00496)	(0.00153)	(0.00170)	(0.00381)
Est. value all other plots	-0.00145	-0.00298	0.000487	-0.000657	-0.000369	-0.00182
	(0.00150)	(0.00185)	(0.00310)	(0.00114)	(0.00139)	(0.00242)
Observations	24,039	17,088	17,088	24,039	17,088	17,088
R-squared	0.385	0.395	0.352	0.230	0.216	0.171
Number of y2_hhid			3,917			3,917

Robust standard errors in parentheses

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

4.3 Fertilizer Factor Allocation Regressions

Fertilizer in the form of manure from animals and livestock is considered a very important investment for farmland. In Tanzania, besides for labor it is probably the most important input the farmers have easy access to. For these reasons I examine also the use of manure as an input. Fertilizer regressions represent the following estimated model:

$$M_{ih} = \beta N_{ih} + \delta X_h + \eta_{jt} + \zeta_{hjt} \tag{10}$$

where M_{ih} the dependent variable is the log of fertilizer per acre applied to plot i in household h. N_{ih} and, X_h are vectors of plot characteristics at the plot and household level. Dummy variables for household (within-transform) and village-wave fixed effects included.

Results from the regression of the log of fertilizer per acre on plot and household control variables are shown in Table 11. Columns 1-2 are pooled OLS and FE-within respectively. Columns 3 and 4 are the same regression, this time including the value of animal portfolio holdings in the place of animal units. As the animal units variable is more likely to be correlated with fertilizer use (often livestock is left overnight on the field for the purposes of fertilizing), this offers the advantage of representing the value of the stock while hopefully being less endogenous. Columns 5-6 mirror 3 and 4, but with fixed effects now included at the village level for the purposes of leveraging the full dataset.

The number of children is negative and strongly significant in columns one, two and four, indicating children and organic fertilizer are, potentially, rough substitutes. A higher number of children corresponds to a lower use of organic fertilizer per acre, and in the case of the model in columns two and four, an increase in the number of children also results in a decrease in the amount of organic fertilizer used.

Organic fertilizer use is decreasing in area planted, as well as decreasing in area planted to all other plots indicating severe constraints to its use. Organic fertilizer use is also increasing in plot expenditure, though the effect is very small.

Rented plots receive less fertilizer, and irrigated plots receive much less fertilizer as well. The fact that the coefficient of rented plots is statistically significant confirms also the results of Gavian and Fafchamps (1996) who find that tenure status affects manuring in Niger. Also similar to their findings, in my estimates area planted to other plots as well as plot distance to

Table 10: Plot-level Hired Labor Demand

VARIABLES	(1) hired_p_labor	(2) hired_p_labor	(3) hired_p_labor	(4) hired_h_labor	(5) hired_h_labor	(6) hired_h_labor
All female mgrs	0.0674**	0.0965***	0.0240	0.0402*	0.0507**	-0.00801
	(0.0273)	(0.0317)	(0.0457)	(0.0208)	(0.0238)	(0.0328)
Mixed gender mgrs	0.0553	0.123**	0.0815	0.0372	0.0226	-0.0215
	(0.0442)	(0.0488)	(0.0635)	(0.0335)	(0.0372)	(0.0521)
Avg. educ of mgrs	0.0347***	0.0386***	0.0474**	0.0246***	0.0212**	0.00956
	(0.0104)	(0.0123)	(0.0186)	(0.00835)	(0.00974)	(0.0153)
Avg. age of mgrs	0.00259	-0.0561***	-0.0261	0.0211*	-0.00164	0.0299
	(0.0146)	(0.0189)	(0.0271)	(0.0116)	(0.0148)	(0.0214)
Avg. BMI of mgrs	-0.00574	0.0192	-0.00723	-0.00848	-0.000623	-0.0109
	(0.00838)	(0.0161)	(0.0211)	(0.00637)	(0.0127)	(0.0197)
Manager is head	0.0369	0.0804*	0.0699	-0.0548*	-0.0306	-0.0250
	(0.0367)	(0.0424)	(0.0588)	(0.0291)	(0.0325)	(0.0470)
Children in HH	-0.0219***	-0.0227***	-0.00511	-0.0195***	-0.0140***	-0.0119
	(0.00376)	(0.00434)	(0.0126)	(0.00304)	(0.00353)	(0.00997)
Adults in HH	-0.0319***	-0.0257***	-0.0342***	-0.0256***	-0.0215***	-0.0288***
	(0.00391)	(0.00458)	(0.0121)	(0.00310)	(0.00352)	(0.00981)
Seniors in HH	0.00847	0.0291*	-0.0404	-0.0103	0.0101	-0.0211
	(0.0140)	(0.0164)	(0.0435)	(0.0108)	(0.0123)	(0.0370)
Population density	0.0125***	0.0114***	0.00670	0.00458*	0.00350	-0.000850
	(0.00350)	(0.00350)	(0.00884)	(0.00261)	(0.00262)	(0.00654)
Total HH assets	0.0609***	0.0530***	0.0183**	0.0339***	0.0283***	0.0104
	(0.00452)	(0.00613)	(0.00913)	(0.00347)	(0.00469)	(0.00689)
Total Farm Asset	-0.0137**	-0.0135	0.0257*	-0.0141***	-0.0202***	-0.00527
	(0.00693)	(0.00914)	(0.0143)	(0.00531)	(0.00702)	(0.0109)
Total animal units	0.0986***	0.144***	-0.0660	0.0681***	0.0760***	-0.0209
	(0.0174)	(0.0207)	(0.0455)	(0.0140)	(0.0165)	(0.0361)
Age of HH head	0.0287	0.0372	0.129	-0.0318	-0.0453**	0.0266
	(0.0249)	(0.0294)	(0.113)	(0.0195)	(0.0224)	(0.0853)
Yr educ HH head	-0.00893	-0.0201*	-0.00275	-0.0199***	-0.0221**	0.0118
	(0.00863)	(0.0104)	(0.0285)	(0.00723)	(0.00871)	(0.0261)
Gender of HH head	0.0229	0.0326	-0.0342	0.0120	0.0101	-0.00805
	(0.0182)	(0.0211)	(0.0739)	(0.0139)	(0.0159)	(0.0598)
HH had a death	0.0349	0.0262	0.0111	0.0183	0.0177	0.0138
	(0.0282)	(0.0314)	(0.0557)	(0.0223)	(0.0250)	(0.0436)
Agricultural wage	-0.00396	-0.00842	-0.0192*	0.0108***	0.00646	0.00633
	(0.00540)	(0.00562)	(0.0107)	(0.00398)	(0.00408)	(0.0103)
Observations	24,039	17,088	17,088	24,039	17,088	17,088
R-squared	0.385	0.395	0.352	0.230	0.216	0.171
Number of y2_hhid			3,917			3,917

Robust standard errors in parentheses

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

household are significant and negative, indicating the "stretching" of limited manure resources across all plots. Further, animal assets and portfolio assets are strongly significant. This again reflects the findings in Gavian and Fafchamps (1996), application of manure is determined by the amount of livestock in a household's herd.

Organic fertilizer use per acre is increasing in the log of population density, possibly because of the higher availability of labor to apply this fertilizer. Intercropped plots receive more fertilizer per acre.

All of the asset variables are strongly significant, though the magnitude varies, with HH assets having the largest effect on fertilizer per acre. Interestingly, gender is not a statistically significant determinant of organic fertilizer use per acre, although the age of the plot manager as well as the log years of education of the manager and plot workers do have a significant and positive effect on the intensity of fertilizer use. Most importantly for rejection, we see that the head of the household being listed as a manager *increases* organic fertilizer use, statistically significant at the .01 % level in all but column two where it is not significant at standard levels.

4.4 Robustness Checks

Due to evidence of recall bias in data collection, some of which came from Tanzania itself (Beegle et al., 2012), I have included a robustness check that adds dummies for the month in which the survey interview was conducted. These dummies are also included in all subsequent robustness checks unless otherwise noted. These results are excluded for brevity, but the results remain largely unchanged, though the interview-month dummies are statistically significant in some cases.

4.4.1 Check 1 - Endogenous HH Size

According to a paper by Grimard (2000), endogeneity of household demographics and composition to agricultural decisions is a significant concern in the context of Cote d'Ivoire, where large kinship networks facilitate the movement of family members to and from regions in need of agricultural labor. In Tanzania, by contrast, the large distances make this type of movement, I argue, much less of a concern, nevertheless, this question can be analyzed using a robustness check.

For this robustness check I exclude all labor which was carried out on the plot by household

Table 11: Fertilizer Factor Allocation Regressions

VARIABLES	(1) Fert per Acre	(2) Fert per Acre	(3) Fert per Acre	(4) Fert per Acre	(5) Fert per Acre	(6) Fert per Acre
Num Children	-0.0115***	-0.0162***	-0.00333	-0.0152***	-0.00333	-0.00333
	(0.00313)	(0.00447)	(0.00363)	(0.00547)	(0.00363)	(0.00482)
Num Adults	0.000571	0.00548	0.00460	0.00247	0.00460	0.00460
	(0.00436)	(0.00646)	(0.00487)	(0.00744)	(0.00487)	(0.00564)
Num Seniors	-0.00400	-0.00486	-0.00488	-0.00651	-0.00488	-0.00488
	(0.0111)	(0.0178)	(0.0133)	(0.0213)	(0.0133)	(0.0164)
Area Planted	-0.0751***	-0.0784***	-0.0656***	-0.0851***	-0.0656***	-0.0656***
	(0.00767)	(0.00993)	(0.00887)	(0.0123)	(0.00887)	(0.0110)
Plot Exp.	0.00629***	0.00727***	0.00547***	0.00660***	0.00547***	0.00547***
	(0.00103)	(0.00136)	(0.00124)	(0.00170)	(0.00124)	(0.00172)
Collective	-0.0146	-0.00618	-0.0387	-0.0320	-0.0387	-0.0387
	(0.0281)	(0.0295)	(0.0386)	(0.0437)	(0.0386)	(0.0428)
Plot is Rented	-0.0955***	-0.141***	-0.108***	-0.155***	-0.108***	-0.108***
	(0.0208)	(0.0307)	(0.0267)	(0.0381)	(0.0267)	(0.0310)
Irrigated	-0.294***	-0.305***	-0.350***	-0.342***	-0.350***	-0.350***
	(0.0471)	(0.0708)	(0.0535)	(0.0834)	(0.0535)	(0.0936)
Pop. Density	0.0230***	0.0167***	0.0336***	0.0266***	0.0336***	0.0336***
	(0.00405)	(0.00467)	(0.00510)	(0.00583)	(0.00510)	(0.00789)
Intercrop Plot	0.0742***	0.0759***	0.0772***	0.0950***	0.0772***	0.0772***
	(0.0103)	(0.0124)	(0.0125)	(0.0156)	(0.0125)	(0.0164)
Imp Seeds	0.0256**	-0.0228	0.0127	-0.0535***	0.0127	0.0127
	(0.0124)	(0.0152)	(0.0146)	(0.0185)	(0.0146)	(0.0191)
Dist to HH	-0.0200***	-0.0213***	-0.0264***	-0.0295***	-0.0264***	-0.0264***
	(0.00102)	(0.00149)	(0.00127)	(0.00194)	(0.00127)	(0.00131)
Area Planted OP	-0.0499***	-0.0319***	-0.0397***	-0.0303***	-0.0397***	-0.0397***
	(0.00577)	(0.00771)	(0.00652)	(0.00923)	(0.00652)	(0.00716)
Plot Value	0.0294***	0.0274***	0.0388***	0.0364***	0.0388***	0.0388***
	(0.00365)	(0.00473)	(0.00461)	(0.00608)	(0.00461)	(0.00515)
HH Assets	0.0163***	0.0110**	0.0268***	0.0263***	0.0268***	0.0268***
	(0.00355)	(0.00507)	(0.00458)	(0.00767)	(0.00458)	(0.00619)
Farm Assets	0.00785***	0.00717***	0.0213***	0.0291***	0.0213***	0.0213***
	(0.00110)	(0.00151)	(0.00154)	(0.00362)	(0.00154)	(0.00181)
Animal Units	0.119***	0.114***				
	(0.00722)	(0.0115)				
Observations	15,284	11,247	11,956	8,211	11,956	11,956
R-squared	0.159		0.149		0.149	
Number of HH		2,658		2,147		
Number of Villages						147
Soil & Slope controls	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes

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

Table 11: Plot-level Fertilizer Factor Allocation

VARIABLES	(1) Fert per Acre	(2) Fert per Acre	(3) Fert per Acre	(4) Fert per Acre	(5) Fert per Acre	(6) Fert per Acre
Age HH Head	0.00807	-0.00465	0.0432	0.00736	0.0432	0.0432
	(0.0292)	(0.0416)	(0.0374)	(0.0567)	(0.0374)	(0.0460)
Educ HH Head	0.0147	0.0135	0.0126	0.0111	0.0126	0.0126
	(0.00920)	(0.0126)	(0.0113)	(0.0157)	(0.0113)	(0.0140)
Gender HH Head	0.0261	0.0372	0.00588	0.0274	0.00588	0.00588
	(0.0201)	(0.0270)	(0.0251)	(0.0342)	(0.0251)	(0.0425)
HH exp a death	-0.00484	0.0124	-0.00373	0.0151	-0.00373	-0.00373
	(0.0157)	(0.0178)	(0.0194)	(0.0231)	(0.0194)	(0.0231)
Plot Mgr is Head	0.0749***	0.0524	0.114***	0.0927**	0.114***	0.114***
	(0.0257)	(0.0338)	(0.0318)	(0.0449)	(0.0318)	(0.0362)
All Female	0.0508**	0.0410	0.0478*	0.0448	0.0478*	0.0478
	(0.0226)	(0.0289)	(0.0281)	(0.0374)	(0.0281)	(0.0461)
Mixed Gender Mgr.	0.0303	0.0212	0.0492	0.0420	0.0492	0.0492
	(0.0296)	(0.0306)	(0.0401)	(0.0451)	(0.0401)	(0.0469)
Educ Mgr.	0.00211	0.0105	0.00280	0.0191	0.00280	0.00280
	(0.0114)	(0.0139)	(0.0140)	(0.0180)	(0.0140)	(0.0151)
Age of Mgr.	0.0195	0.0333	0.00185	0.0293	0.00185	0.00185
	(0.0243)	(0.0320)	(0.0316)	(0.0430)	(0.0316)	(0.0318)
BMI of Mgr.	-0.00187	-0.00663	-0.00436	-0.0127	-0.00436	-0.00436
	(0.00631)	(0.0127)	(0.00696)	(0.0165)	(0.00696)	(0.00523)
Avg Age Prep Labor	-0.00194	-0.00123	0.0110	0.00758	0.0110	0.0110
	(0.0103)	(0.0143)	(0.0124)	(0.0197)	(0.0124)	(0.0150)
Avg BMI Prep Labor	0.00201	0.0209	0.000965	0.0224	0.000965	0.000965
	(0.00347)	(0.0130)	(0.00360)	(0.0194)	(0.00360)	(0.00255)
Avg Educ Prep Labor	0.0216***	0.0180**	0.0193**	0.0125	0.0193**	0.0193**
	(0.00702)	(0.00898)	(0.00863)	(0.0116)	(0.00863)	(0.00876)
Animal Holdings			3.11e-09***	1.26e-08**	3.11e-09***	3.11e-09***
			(7.88e-10)	(4.94e-09)	(7.88e-10)	(8.57e-10)
Observations	15,284	11,247	11,956	8,211	11,956	11,956
R-squared	0.159		0.149		0.149	
Number of HH		2,658		2,147		
Number of Villages						147
Soil & Slope controls	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes

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

members who have recently joined the household as a measure to control against endogeneity of household composition to agricultural labor decisions. Based on the survey questionnaire it is possible to identify which household members have joined the household in the past year and for what reason they have moved. In this robustness check, all labor contributions by survey participants who reported moving in the last year due to acquiring agricultural land or for work purposes are excluded. The test in this case still strongly rejects labor market completeness and the results can be found in Table 14.

4.4.2 Check 2 - Farm Size Check

The third robustness check, Table 15, evaluates whether farms of different sizes have different demands for labor. Farms are broken into quantiles based on the area under control by each farm. The smallest quantile of farms are approximately less than a football field, the largest quantile farms are over ten football fields in size. All tests still reject labor market completeness, although households in the largest quantile of farms appear to be the most constrained in their labor use.

4.4.3 Check 3 - Individual Crop Regressions

In order to better understand Tanzanian agricultural labor markets, and owing to the large sample size of this survey, I run regressions for several crops individually including maize, paddy (rice), sweet potatoes, legumes, cotton, and tobacco. These results are reported in the appendix in regression tables 16-21.

Maize and rice are both staple and cash crop, legumes and sweet potatoes are considered staple crops. It therefore seems consistent that an increase in the acreage planted to maize, legumes, or sweet potatoes increases family prep and harvest labor the most. Similarly, a higher number of adult household members of working age (12-65) corresponds to higher plot labor demand *for all crops*. This implies that there are no localized areas where the tests fail to reject separability between household composition and farm labor use.

With respect to hired labor, an increase in acres planted to tobacco or cotton increases hired labor the most, with each additional acre of land planted to cotton increasing hired harvest labor by 65%. This indicates that hired labor markets are not totally dysfunctional, although the *level* of reported hired labor use remains fairly low relative to other, more densely populated

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countries. Lastly, household assets appear to be an important determinant of hired labor use in many cases, or at least of access to hired labor. This indicates that some households are potentially constrained in the amount of working capital they have access to, and implies credit markets are also dysfunctional.

5 Conclusion

This paper uses high-quality panel data from Tanzania to examine labor market inefficiencies. I first check for differences in the efficiencies of family and hired labor. Using two tests I find that hired labor is more efficient than family labor, though in the harvest season the differential in productivities between hired and family labor decreases according to the Deolalikar-Vijverberg test. This result is important because differentials between family and hired labor are considered to be an important potential source of labor market inefficiency.

In all specifications my test rejects the completeness of labor markets, and confirms the non-separable nature of household production and consumption decisions. In all cases, increases in the number of working adults in the household results in increases in labor applied to the household farm, measured at the plot level. Crop-disaggregated analysis indicates that most hired labor is applied to plots where cash crops, such as tobacco and cotton, rather than staple crops are cultivated.

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		(1)	(2)	(3)	(4)	(5)	(13)	(14)	(15)	(16)	(17)
	VARIABLES	N	mean	sd	min	max	p10	p25	p50	p75	p90
	# HH Members	3,265	5.118	2.892	1	46	2	3	5	7	9
	# Married Members	3,265	3.232	1.861	1	23	1	2	3	4	6
	# Children	3,265	1.793	1.657	0	23	0	0	2	3	4
	# Adult members	3,265	2.963	1.833	0	22	1	2	2	4	5
	# Adult Men	3,265	1.405	1.154	0	10	0	1	1	2	3
	# Adult Women	3,265	1.558	1.109	0	12	1	1	1	2	3
	# Senior	3,265	0.228	0.511	0	3	0	0	0	0	1
Wave 1	HH Avg. Age	3,265	25.89	13.22	8	87	14.5	17.2	22.3	29.5	41.33
	HH Avg. Adult Years Educ.	3,153	4.701	3.194	0	22	0	2.333	4.5	7	8.333
	HH Avg. Adult Age	3,153	31.05	7.988	13	64	23	26	29.5	34.33	40.33
	HH Head is Married	3,265	0.21	0.407	0	1	0	0	0	0	1
	Age HH Head	3,264	45.86	15.49	18	102	28	33	43	56	69
	Years Educ HH Head	3,265	1.949	3.716	0	22	0	0	0	2	7
	Gender HH Head	3,265	0.111	0.314	0	1	0	0	0	0	1
	Farm Area	3,265	28.08	146.9	0	6,413	0	0	7.5	24	56
	Total HH Assets (in 1000's of 2015 TSH)	3,265	3952	5984	0	86630	678.253	2045	2486	4214	6436
	VARIABLES	N	mean	sd	min	max	p10	p25	p50	p75	p90
	# HH Members	3,917	5.247	3.116	1	55	2	3	5	7	9
	# Married Members	3,917	3.421	2.054	1	31	1	2	3	4	6
	# Children	3,917	1.799	1.704	0	24	0	0	2	3	4
	# Adult members	3,917	3.079	1.936	0	29	1	2	3	4	6
	# Adult Men	3,917	1.475	1.214	0	13	0	1	1	2	3
	# Adult Women	3,917	1.604	1.152	0	16	1	1	1	2	3
	# Senior	3,917	0.229	0.507	0	3	0	0	0	0	1
Wave 2	HH Avg. Age	3,917	25.61	12.69	8.2	89	14.5	17.33	22.25	29.17	40.67
	HH Avg. Adult Years Educ.	3,806	4.887	3.274	0	22	0	2.6	4.667	7	9
	HH Avg. Adult Age	3,806	30.78	7.759	13	64	23	25.86	29.5	34	40
	HH Head is Married	3,917	0.165	0.372	0	1	0	0	0	0	1
	Age HH Head	3,917	12.5	21.86	0	99	0	0	0	26	48
	Years Educ HH Head	3,917	1.671	3.63	0	22	0	0	0	0	7
	Gender HH Head	3,917	0.085	0.279	0	1	0	0	0	0	0
	Farm Area	3,917	32.97	162.7	0	6,886	0	0	6.33	25.35	67.65
	Total HH Assets (in 1000's of 2015 TSH)	3,917	3198	4110	0	62900	390.498	1692	2118	3619	5417

	VARIABLES	N	mean	sd	min	max	p10	p25	p50	p75	p90
	# HH Members	5,010	5.072	3.163	1	54	2	3	5	7	9
	# Married Members	5,010	3.328	2.038	1	28	1	2	3	4	6
	# Children	5,010	1.705	1.714	0	26	0	0	1	3	4
	# Adult members	5,010	3.026	1.907	0	25	1	2	2	4	6
	# Adult Men	5,010	1.458	1.181	0	12	0	1	1	2	3
	# Adult Women	5,010	1.568	1.114	0	13	1	1	1	2	3
	# Senior	5,010	0.216	0.5	0	3	0	0	0	0	1
Wave 3	HH Avg. Age	5,010	25.69	12.64	7.5	92	14.55	17.4	22.13	29.5	40.75
	HH Avg. Adult Years Educ.	4,881	5.318	3.388	0	20.5	1	3	5	7	10
	HH Avg. Adult Age	4,881	30.56	7.92	13	64	22.5	25.5	29	33.67	40.5
	HH Head is Married	5,010	0.712	0.453	0	1	0	0	1	1	1
	Age HH Head	5,010	45.3	16.12	0	108	26	33	43	56	69
	Years Educ HH Head	5,010	5.973	4.727	0	22	0	1	7	7	13
	Gender HH Head	5,010	0.246	0.431	0	1	0	0	0	0	1
	Farm Area	5,010	19.16	103.4	0	4,057	0	0	2.76	12.18	37.33
	Total HH Assets (in 1000's of 2015 TSH)	5,010	476700	32500000	0	2301000000	138.032	356.582	1170	5863	27700

	VARIABLES	N	mean	sd	min	max	p10	p25	p50	p75	p90
	# HH Members	3,352	4.858	2.849	1	33	2	3	4	6	8
	# Married Members	3,352	3.034	1.744	1	15	1	2	3	4	5
	# Children	3,352	1.811	1.712	0	19	0	0	1	3	4
	# Adult members	3,352	2.75	1.646	0	13	1	2	2	3	5
	# Adult Men	3,352	1.301	1.084	0	9	0	1	1	2	3
	# Adult Women	3,352	1.449	0.973	0	7	1	1	1	2	3
	# Senior	3,352	0.17	0.432	0	3	0	0	0	0	1
Wave 4	HH Avg. Age	3,352	25.09	12.81	7.333	93	14	16.75	21.33	29	42
	HH Avg. Adult Years Educ.	3,352	4.983	3.828	0	21	0	2.2	4.667	7	10
	HH Avg. Adult Age	3,352	30.09	8.659	16	64	18	24.67	29	34.25	41
	HH Head is Married	3,352	0.706	0.456	0	1	0	0	1	1	1
	Age HH Head	3,352	44.42	14.99	16	100	27	33	42	54	65
	Years Educ HH Head	3,352	6.025	4.796	0	22	0	0	7	7	13
	Gender HH Head	3,352	0.285	0.451	0	1	0	0	0	1	1
	Farm Area	3,352	17.58	86.7	0	2,610	0	0	1.745	10.25	33.34
	Total HH Assets (in 1000's of 2015 TSH)	3,352	15700	126700	0	5589000	137.546	348.519	1092	5893	26800

Table 12: Caption

VARIABLES	N	mean	sd	min	max	skewness	kurtosis	p25	p50	p75
Distance to Household	18,569	4.046	4.169	0.01	18	1.641	4.854	1.5	2	5
Plot is irrigated	413	1	0	1	1					
Farmer's est value of plot (x10,000TSH)	22918	363	6487	0	827300	0	1	22	52	138
Organic fertilizer applied (manure)	2,166	926.4	1,892	2	32,000	6.434	65.97	150	350	1,000
Plot is rented	841	1	0	1	1					
Est. value of all other plots in HH (x10,000TSH)	20940	582	5555	0	345100	0	0	33	92	264
All female managers	4,254	1	0	1	1					
Mixed gender managers	9,242	1	0	1	1					
Plot manager is head	18,217	1	0	1	1					
Collective plot	9,746	1	0	1	1					
Avg years of educ of mgrs	24,249	10.47	8.234	1	46	0.103	1.921	1	13	17.5
Avg age of mgrs	24,249	36.81	22.52	1	100	-0.255	2.28	26	39.5	52
Avg BMI of mgrs	24,249	67.46	781.8	1	20,001	16.31	302.7	1	19.17	22.58
Area planted	15,275	3.563	9.44	0.0025	338.7	15.36	379.4	0.615	1.5	3.47
Plot is intercropped	8,082	1	0	1	1					
Plot planted to improved seeds	7,441	1	0	1	1					
Total plot expenditure	10954	86713	255028	2	7608000	12	217	10000	30000	75000
Area planted to all other plots	15,760	5.106	10.55	0.005	338.7	11.1	217.4	1	2.387	5.446

Table 13: Summary Statistics of Plot-level Regression Variables

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VARIABLES	N	mean	sd	min	max	skewness	kurtosis	p25	p50	p75
Age of HH head	24,146	48.18	15.49	0	108	0.485	2.671	36	46	59
Years of educ of HH head	24,146	5.071	4.034	0	22	0.509	3.473	0	7	7
Gender of HH head	24,146	0.778	0.416	0	1	-1.336	2.785	1	1	1
Number of Children in HH	24,146	2.107	1.883	0	26	1.907	15.35	1	2	3
Number of adult HH members	24,146	2.993	1.871	0	25	1.823	11.31	2	2	4
Number of senior HH members	24,146	0.263	0.541	0	3	2.036	6.569	0	0	0
Agricultural wage (imputed)	25467	136	103	0	325	0	0	54	98	182
Animal Units	14,039	6.392	29.36	0.005	527	13.63	219.4	0.09	0.495	4
Total farm assets (x10,000TSH)	19100	585	6774	0	333800	0	0	13	42	185
Total HH assets (x10,000TSH)	24108	862	10700	0	590900	0	0	89	223	424
Population density (per 0.25km2)	19,018	779.1	4,828	0	77,028	10.41	130.5	10	30	89
Soil type (type 1=Sandy)	4,206	1	0	1	1					
Soil type (type 2= Loam)	15,334	1	0	1	1					
Soil type (type 3=Clay)	4,107	1	0	1	1					
Soil type (type 4= Other)	539	1	0	1	1					
Plot slope (1 = Flat bottom)	14,653	1	0	1	1					
Plot slope (2 = Flat top)	1,437	1	0	1	1					
Plot slope (3 = Slightly sloped)	6,422	1	0	1	1					
Plot slope (4 = Very steep)	822	1	0	1	1					

Table 13: Summary Statistics of Plot-level Regression Variables

Table 14: Robustness 2 - Endogenous HH Size Check

VARIABLES	(1) prep_days_r2	(2) prep_days_r2	(3) harv_days_r2	(4) harv_days_r2	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.345***	0.363***	0.298***	0.382***	0.183***	0.210***	0.159***	0.176***
	(0.0284)	(0.0211)	(0.0261)	(0.0187)	(0.0203)	(0.0153)	(0.0167)	(0.0126)
Plot Expense	0.00743***	-0.00847***	0.0148***	0.00520**	0.116***	0.120***	0.0463***	0.0504***
	(0.00286)	(0.00246)	(0.00292)	(0.00232)	(0.00292)	(0.00194)	(0.00210)	(0.00152)
Collective Plot	0.353***	0.341***	0.432***	0.369***	-0.0870	-0.142***	-0.00789	-0.0398
	(0.111)	(0.0697)	(0.101)	(0.0608)	(0.0606)	(0.0463)	(0.0493)	(0.0355)
Rented In	0.120**	-0.0212	0.0534	0.00233	-0.517***	-0.518***	-0.166***	-0.146***
	(0.0592)	(0.0499)	(0.0549)	(0.0458)	(0.0570)	(0.0479)	(0.0469)	(0.0386)
Irrigated	-0.168**	-0.310***	0.106	-0.255***	0.00402	0.0458	0.0888	0.183***
	(0.0841)	(0.0789)	(0.0844)	(0.0715)	(0.0890)	(0.0714)	(0.0688)	(0.0592)
Organic Fert. Used	0.0289***	0.00911	0.0154**	0.00404	-0.0246***	-0.0235***	-0.00694	-0.00766*
	(0.00656)	(0.00610)	(0.00656)	(0.00574)	(0.00566)	(0.00533)	(0.00551)	(0.00415)
Plot is Intercropped	0.0148	0.0308	-0.0989***	-0.134***	-0.0657***	-0.125***	-0.0800***	-0.116***
	(0.0274)	(0.0249)	(0.0269)	(0.0231)	(0.0214)	(0.0195)	(0.0175)	(0.0152)
Plot Used Improved Seeds	0.0159	0.000394	-0.0710**	-0.0767***	-0.233***	-0.289***	-0.0738***	-0.0912***
	(0.0321)	(0.0283)	(0.0323)	(0.0275)	(0.0245)	(0.0223)	(0.0197)	(0.0171)
Plot Dist. to HH	0.0159***	0.00952***	0.0114***	0.00464*	0.0171***	0.0217***	0.00850***	0.0109***
	(0.00315)	(0.00268)	(0.00298)	(0.00250)	(0.00267)	(0.00213)	(0.00199)	(0.00169)
Area Planted Other Plots	-0.138***	-0.132***	-0.0339	0.00180	0.0213	0.0265**	0.0167	0.0252***
	(0.0253)	(0.0143)	(0.0236)	(0.0131)	(0.0184)	(0.0103)	(0.0147)	(0.00839)
Plot Value	0.0328***	0.0191***	0.0453***	0.0140***	0.00954*	0.000991	0.0123***	0.00288*
	(0.00669)	(0.00345)	(0.00688)	(0.00317)	(0.00494)	(0.00238)	(0.00384)	(0.00171)
Value All Other Plots	0.000656	0.00625**	-0.00149	-7.30e-05	0.000258	-0.00280	-0.00218	-0.000472
	(0.00410)	(0.00244)	(0.00395)	(0.00229)	(0.00310)	(0.00185)	(0.00243)	(0.00140)
Observations	17,086	17,086	17,086	17,086	17,086	17,086	17,086	17,086
R-squared	0.538	0.587	0.367	0.452	0.353	0.396	0.172	0.218
Number of HH	3,917		3,917		3,917		3,917	

Robust standard errors in parentheses

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

Table 14: Robustness 2 - Endogenous HH Size Check

VARIABLES	(1) prep_days_r2	(2) prep_days_r2	(3) harv_days_r2	(4) harv_days_r2	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Mgrs. All Female	-0.110	-0.104**	-0.190***	-0.209***	0.0247	0.0883***	-0.00429	0.0423*
	(0.0693)	(0.0425)	(0.0685)	(0.0418)	(0.0460)	(0.0318)	(0.0329)	(0.0238)
Mgrs. Mixed Gender	-0.142	-0.0795	-0.341***	-0.248***	0.0809	0.119**	-0.0136	0.0182
	(0.115)	(0.0739)	(0.107)	(0.0639)	(0.0634)	(0.0488)	(0.0508)	(0.0372)
Avg. Educ of Mgrs.	0.0411	0.0322*	0.0750***	0.0535***	0.0476**	0.0395***	0.00877	0.0200**
	(0.0290)	(0.0172)	(0.0268)	(0.0158)	(0.0185)	(0.0123)	(0.0152)	(0.00973)
Avg. Age of Mgrs.	0.784***	0.848***	0.552***	0.571***	-0.0248	-0.0537***	0.0297	-0.000179
	(0.0414)	(0.0262)	(0.0378)	(0.0245)	(0.0271)	(0.0189)	(0.0214)	(0.0148)
Avg. BMI of Mgrs.	0.0715**	0.0434*	0.0246	0.0272	-0.00851	0.0178	-0.0108	0.000841
	(0.0326)	(0.0223)	(0.0288)	(0.0202)	(0.0211)	(0.0161)	(0.0197)	(0.0128)
Mgr. is Head	-0.206***	-0.170***	-0.137*	-0.0886*	0.0683	0.0797*	-0.0270	-0.0353
	(0.0798)	(0.0542)	(0.0771)	(0.0529)	(0.0592)	(0.0424)	(0.0471)	(0.0326)
# Children (r2)	0.0531***	0.0202***	0.0276	0.0382***	-0.00877	-0.0233***	-0.0161	-0.0149***
	(0.0191)	(0.00635)	(0.0174)	(0.00573)	(0.0121)	(0.00425)	(0.00987)	(0.00342)
# Adult Members (r2)	0.0135	0.0530***	0.0334**	0.0599***	-0.0261**	-0.0309***	-0.0148*	-0.0244***
	(0.0160)	(0.00718)	(0.0153)	(0.00674)	(0.0104)	(0.00518)	(0.00852)	(0.00399)
# Seniors (r2)	-0.180***	-0.0674***	-0.147***	-0.0872***	-0.0365	0.0319*	-0.00611	0.0189
	(0.0667)	(0.0235)	(0.0542)	(0.0215)	(0.0375)	(0.0167)	(0.0313)	(0.0128)
Pop Density (in persons per km^2)	-0.00259	-0.0262***	0.0133	-0.0275***	0.00643	0.0127***	-0.000379	0.00359
	(0.0127)	(0.00513)	(0.0128)	(0.00503)	(0.00902)	(0.00353)	(0.00662)	(0.00262)
HH Assets	-0.0359***	-0.0530***	-0.0242*	-0.0387***	0.0176*	0.0526***	0.00840	0.0272***
	(0.0137)	(0.00773)	(0.0125)	(0.00769)	(0.00903)	(0.00610)	(0.00694)	(0.00466)
Farm Assets	-0.0301	-0.00398	-0.0258	0.000498	0.0252*	-0.0114	-0.00532	-0.0185***
	(0.0205)	(0.0115)	(0.0204)	(0.0117)	(0.0144)	(0.00916)	(0.0109)	(0.00703)
Animal Units	0.226***	-0.147***	0.190***	-0.0326	-0.0659	0.138***	-0.0272	0.0686***
	(0.0711)	(0.0265)	(0.0658)	(0.0250)	(0.0453)	(0.0207)	(0.0361)	(0.0165)
Age HH Head	-0.375***	-0.405***	-0.245*	-0.261***	0.106	0.0311	-0.00980	-0.0558**
	(0.145)	(0.0394)	(0.136)	(0.0372)	(0.111)	(0.0285)	(0.0851)	(0.0218)
Educ HH Head	0.0290	-0.0255*	-0.0719**	-0.0338***	-0.00195	-0.0206**	0.0134	-0.0208**
	(0.0366)	(0.0139)	(0.0317)	(0.0124)	(0.0283)	(0.0103)	(0.0260)	(0.00867)
Gender HH Head	-0.147	-0.132***	-0.0287	-0.0711**	-0.0354	0.0281	-0.0112	0.00610
	(0.113)	(0.0302)	(0.106)	(0.0291)	(0.0741)	(0.0211)	(0.0598)	(0.0159)
HH Death	0.0131	0.0363	-0.0330	0.0374	0.00851	0.0199	0.0151	0.0158
	(0.0738)	(0.0429)	(0.0712)	(0.0401)	(0.0556)	(0.0315)	(0.0438)	(0.0250)
Ag Wage	0.0108	-0.0122	-0.0170	-0.0201***	-0.0162	-0.00846	0.00780	0.00672
	(0.0164)	(0.00796)	(0.0147)	(0.00750)	(0.0107)	(0.00566)	(0.0103)	(0.00410)
Observations	17,086	17,086	17,086	17,086	17,086	17,086	17,086	17,086
R-squared	0.538	0.587	0.367	0.452	0.353	0.396	0.172	0.218
Number of HH	3,917		3,917		3,917		3,917	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Robustness 2 - Endogenous HH Size Check

VARIABLES	(1) prep_days_r2	(2) prep_days_r2	(3) harv_days_r2	(4) harv_days_r2	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
interview_month 2.	0.0656	0.00209	0.229***	0.0628	-0.00162	0.00606	0.0476	0.0364
	(0.0939)	(0.0437)	(0.0833)	(0.0429)	(0.0692)	(0.0343)	(0.0487)	(0.0263)
interview_month 3.	0.00641	0.0685	0.0728	0.133***	0.0737	0.0408	0.0585	0.0444
	(0.115)	(0.0462)	(0.104)	(0.0462)	(0.0781)	(0.0358)	(0.0556)	(0.0279)
interview_month 4.	0.0428	-0.0959*	-0.0377	-0.0499	-0.00722	0.0413	0.0176	0.0230
	(0.140)	(0.0493)	(0.126)	(0.0463)	(0.100)	(0.0378)	(0.0737)	(0.0303)
interview_month 5.	-0.0216	-0.0978**	-0.176	-0.0348	-0.135	-0.0389	-0.0830	-0.0197
	(0.135)	(0.0467)	(0.125)	(0.0428)	(0.100)	(0.0343)	(0.0732)	(0.0259)
interview_month 6.	-0.0844	-0.0625	-0.148	-0.0222	-0.133	-0.0251	-0.117	-0.0358
	(0.142)	(0.0494)	(0.128)	(0.0452)	(0.102)	(0.0340)	(0.0758)	(0.0262)
.interview_month 7	-0.125	-0.0824*	-0.220*	0.0125	-0.0549	-0.00593	-0.0814	0.0183
	(0.146)	(0.0449)	(0.129)	(0.0433)	(0.106)	(0.0347)	(0.0800)	(0.0272)
interview_month 8.	-0.0341	-0.0819*	-0.105	-0.0450	0.0194	-0.00497	-0.110	-0.00423
	(0.152)	(0.0453)	(0.135)	(0.0427)	(0.107)	(0.0333)	(0.0837)	(0.0263)
interview_month 9.	-0.266	-0.00650	-0.313**	-0.0713	-0.0142	-0.116***	-0.0529	-0.0213
	(0.177)	(0.0514)	(0.156)	(0.0480)	(0.123)	(0.0381)	(0.0962)	(0.0304)
interview_month 10.	-0.0931	-0.0275	-0.0452	-0.0618	0.0893	0.0273	0.0228	-0.0531**
	(0.149)	(0.0466)	(0.130)	(0.0438)	(0.0923)	(0.0322)	(0.0682)	(0.0246)
interview_month 11.	-0.0453	0.0189	-0.0411	-0.0225	0.0549	-0.00402	0.0688	0.0171
	(0.128)	(0.0435)	(0.111)	(0.0415)	(0.0814)	(0.0305)	(0.0622)	(0.0241)
interview_month 12.	0.0666	0.0540	-0.0632	0.0336	0.0337	-0.0277	0.0144	-0.0269
	(0.106)	(0.0437)	(0.0981)	(0.0434)	(0.0697)	(0.0320)	(0.0560)	(0.0241)
Observations	17,086	17,086	17,086	17,086	17,086	17,086	17,086	17,086
R-squared	0.538	0.587	0.367	0.452	0.353	0.396	0.172	0.218
Number of y2_hhid	3,917		3,917		3,917		3,917	

Robust standard errors in parentheses

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

Table 15: Robustness 3 - Farm Size Check

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.432***	0.498***	0.323***	0.408***	0.167***	0.185***	0.149***	0.169***
	(0.0244)	(0.0166)	(0.0259)	(0.0186)	(0.0209)	(0.0161)	(0.0172)	(0.0132)
Plot Expense	0.00877***	-0.0116***	0.0170***	0.00520**	0.115***	0.119***	0.0460***	0.0502***
	(0.00241)	(0.00200)	(0.00280)	(0.00223)	(0.00294)	(0.00194)	(0.00212)	(0.00152)
Collective Plot	0.389***	0.396***	0.331***	0.304***	-0.0849	-0.144***	-0.0130	-0.0393
	(0.0784)	(0.0547)	(0.0943)	(0.0600)	(0.0618)	(0.0466)	(0.0506)	(0.0357)
Plot is Rented In	0.161***	0.0469	0.0566	-0.00205	-0.450***	-0.451***	-0.123**	-0.115***
	(0.0482)	(0.0411)	(0.0563)	(0.0465)	(0.0610)	(0.0501)	(0.0506)	(0.0407)
Plot is Irrigated	-0.0501	-0.266***	0.161*	-0.260***	0.00371	0.0227	0.0789	0.167***
	(0.0689)	(0.0651)	(0.0862)	(0.0710)	(0.0900)	(0.0707)	(0.0695)	(0.0589)
Organic Fert. Applied	0.0309***	0.00959**	0.0142**	0.00101	-0.0248***	-0.0254***	-0.00800	-0.00901**
	(0.00525)	(0.00465)	(0.00627)	(0.00553)	(0.00572)	(0.00536)	(0.00554)	(0.00416)
Plot is Intercropped	-0.0132	-0.0188	-0.114***	-0.151***	-0.0580***	-0.119***	-0.0767***	-0.116***
	(0.0217)	(0.0194)	(0.0257)	(0.0219)	(0.0216)	(0.0195)	(0.0175)	(0.0153)
Plot Used Improved Seeds	-0.00788	-8.98e-05	-0.0897***	-0.0817***	-0.232***	-0.281***	-0.0742***	-0.0881***
	(0.0262)	(0.0231)	(0.0306)	(0.0266)	(0.0248)	(0.0227)	(0.0200)	(0.0174)
Plot Dist. to HH	0.0182***	0.00687***	0.0110***	0.00308	0.0189***	0.0243***	0.00948***	0.0122***
	(0.00296)	(0.00237)	(0.00306)	(0.00256)	(0.00282)	(0.00225)	(0.00211)	(0.00179)
Area Planted All Other Plots	-0.0963***	-0.0980***	-0.00818	0.0160	0.0153	0.0287**	0.0149	0.0319***
	(0.0211)	(0.0121)	(0.0234)	(0.0134)	(0.0193)	(0.0112)	(0.0154)	(0.00924)
Plot Value	0.0578***	0.0177***	0.0767***	0.0354***	0.0247***	0.0386***	0.0268***	0.0237***
	(0.00946)	(0.00645)	(0.0104)	(0.00680)	(0.00788)	(0.00537)	(0.00600)	(0.00387)
Value All Other Plots	-0.00337	-0.000787	-0.00364	-0.00362	0.000701	-0.00245	-0.00115	0.000494
	(0.00350)	(0.00211)	(0.00406)	(0.00237)	(0.00338)	(0.00205)	(0.00268)	(0.00157)
Observations	16,365	16,365	16,365	16,365	16,365	16,365	16,365	16,365
R-squared	0.579	0.666	0.338	0.452	0.347	0.396	0.167	0.218
Number of HH	3,887		3,887		3,887		3,887	
Soil & Slope Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15: Robustness 3 ctd - Farm Size Check

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Mgrs. All Female	-0.185***	-0.218***	-0.219***	-0.224***	0.0467	0.130***	0.00208	0.0582**
	(0.0641)	(0.0388)	(0.0704)	(0.0426)	(0.0490)	(0.0332)	(0.0350)	(0.0248)
Mgrs. Are Mixed Gender	-0.192**	-0.210***	-0.262***	-0.227***	0.0869	0.124**	-0.00650	0.0186
	(0.0816)	(0.0569)	(0.0986)	(0.0627)	(0.0646)	(0.0490)	(0.0522)	(0.0374)
Avg Yrs. of Educ of Mgrs.	0.0267	-0.0171	0.0541**	0.0310**	0.0544***	0.0521***	0.00920	0.0254**
	(0.0241)	(0.0147)	(0.0273)	(0.0158)	(0.0195)	(0.0130)	(0.0157)	(0.0103)
Avg Age of Mgrs.	0.867***	0.905***	0.587***	0.597***	-0.0281	-0.0503***	0.0358	0.00190
	(0.0374)	(0.0242)	(0.0377)	(0.0246)	(0.0284)	(0.0195)	(0.0223)	(0.0153)
Avg BMI of Mgrs.	0.0409	0.0334*	0.0150	0.0227	-0.0111	0.0194	-0.0127	0.00182
	(0.0259)	(0.0181)	(0.0279)	(0.0192)	(0.0219)	(0.0162)	(0.0201)	(0.0128)
Mgr. is Head	-0.221***	-0.136***	-0.124	-0.0470	0.0862	0.112***	-0.0268	-0.0220
	(0.0759)	(0.0507)	(0.0790)	(0.0534)	(0.0610)	(0.0433)	(0.0487)	(0.0332)
# Children	0.0148	0.0333***	0.0146	0.0408***	-0.00635	-0.0214***	-0.0188*	-0.0143***
	(0.0134)	(0.00500)	(0.0161)	(0.00579)	(0.0130)	(0.00448)	(0.0106)	(0.00360)
# Adult Members	0.0809***	0.0737***	0.0798***	0.0744***	-0.0287**	-0.0357***	-0.0130	-0.0256***
	(0.0120)	(0.00635)	(0.0151)	(0.00716)	(0.0119)	(0.00565)	(0.00941)	(0.00428)
# Seniors	0.0684	-0.0398**	0.0259	-0.0303	-0.0382	0.0282*	-0.0126	0.0126
	(0.0506)	(0.0195)	(0.0596)	(0.0215)	(0.0464)	(0.0171)	(0.0389)	(0.0130)
Pop Density (in persons per km^2)	-0.00450	-0.0334***	0.0193	-0.0305***	0.00623	0.00979***	0.000534	0.00169
	(0.0104)	(0.00476)	(0.0124)	(0.00535)	(0.00939)	(0.00375)	(0.00700)	(0.00281)
HH Assets	-0.0232**	-0.0581***	-0.0248**	-0.0496***	0.0184**	0.0504***	0.0100	0.0261***
	(0.0101)	(0.00674)	(0.0117)	(0.00768)	(0.00916)	(0.00619)	(0.00703)	(0.00472)
Farm Assets	-0.0121	-0.00769	0.00158	0.0130	0.0247*	-0.000994	-0.00407	-0.0111
	(0.0155)	(0.00940)	(0.0180)	(0.0112)	(0.0146)	(0.00947)	(0.0111)	(0.00729)
Animal Units	0.152***	-0.116***	0.151**	-0.0493*	-0.0518	0.138***	-0.0105	0.0670***
	(0.0540)	(0.0229)	(0.0613)	(0.0254)	(0.0480)	(0.0220)	(0.0381)	(0.0175)
Age HH Head	-0.538***	-0.376***	-0.329**	-0.280***	0.112	0.0251	-0.00747	-0.0562**
	(0.121)	(0.0373)	(0.130)	(0.0394)	(0.116)	(0.0308)	(0.0871)	(0.0236)
Educ HH Head	0.0115	-0.0271**	-0.0630**	-0.0373***	-0.00129	-0.0377***	0.0197	-0.0291***
	(0.0314)	(0.0126)	(0.0312)	(0.0131)	(0.0283)	(0.0113)	(0.0245)	(0.00952)
Gender HH Head	-0.195**	-0.0919***	-0.0587	-0.0559*	-0.0242	0.0503**	-0.0102	0.0176
	(0.0856)	(0.0293)	(0.102)	(0.0313)	(0.0770)	(0.0230)	(0.0617)	(0.0174)
HH Death	-0.0395	-0.0148	-0.0116	0.0260	0.00977	0.0156	0.0204	0.0144
	(0.0652)	(0.0382)	(0.0722)	(0.0418)	(0.0601)	(0.0337)	(0.0471)	(0.0268)
Ag Wage	0.00709	-0.0123*	-0.0209	-0.0255***	-0.0194*	-0.00892	0.00810	0.00703
	(0.0116)	(0.00686)	(0.0144)	(0.00788)	(0.0106)	(0.00600)	(0.00948)	(0.00438)
Observations	16,365	16,365	16,365	16,365	16,365	16,365	16,365	16,365
R-squared	0.579	0.666	0.338	0.452	0.347	0.396	0.167	0.218
Number of HH	3,887		3,887		3,887		3,887	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15: Robustness 3 ctd - Farm Size Check

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Interview Month 2	0.0953	-0.0483	0.291***	0.0578	-0.000918	0.00854	0.0528	0.0416
	(0.0680)	(0.0392)	(0.0820)	(0.0445)	(0.0710)	(0.0364)	(0.0500)	(0.0280)
Interview Month 3	0.119	0.0571	0.148	0.112**	0.0761	0.0358	0.0648	0.0440
	(0.0854)	(0.0402)	(0.0991)	(0.0467)	(0.0798)	(0.0372)	(0.0568)	(0.0292)
Interview Month 4	0.105	-0.142***	0.0700	-0.0723	-0.00568	0.0168	0.0140	0.0133
	(0.108)	(0.0424)	(0.119)	(0.0457)	(0.101)	(0.0386)	(0.0744)	(0.0311)
Interview Month 5	0.0765	-0.0481	-0.105	-0.0503	-0.129	-0.0548	-0.0796	-0.0241
	(0.106)	(0.0388)	(0.119)	(0.0426)	(0.102)	(0.0356)	(0.0743)	(0.0269)
Interview Month 6	0.00864	-0.0561	-0.0922	-0.0526	-0.134	-0.0368	-0.110	-0.0400
	(0.111)	(0.0406)	(0.121)	(0.0450)	(0.104)	(0.0353)	(0.0779)	(0.0272)
Interview Month 7	-0.0935	-0.0978**	-0.173	-0.00970	-0.0439	-0.0241	-0.0683	0.0131
	(0.115)	(0.0393)	(0.123)	(0.0431)	(0.109)	(0.0359)	(0.0825)	(0.0283)
Interview Month 8	-0.0490	-0.0420	-0.0438	-0.0450	0.0224	-0.0152	-0.108	-0.00694
	(0.118)	(0.0370)	(0.126)	(0.0422)	(0.110)	(0.0345)	(0.0868)	(0.0274)
Interview Month 9	-0.247*	-0.0171	-0.280*	-0.0978**	-0.0149	-0.128***	-0.0366	-0.0218
	(0.133)	(0.0433)	(0.144)	(0.0495)	(0.129)	(0.0404)	(0.101)	(0.0322)
Interview Month 10	-0.0605	0.00950	0.0655	-0.0727*	0.0975	0.0137	0.0309	-0.0603**
	(0.108)	(0.0389)	(0.119)	(0.0438)	(0.0949)	(0.0335)	(0.0695)	(0.0257)
Interview Month 11	0.0637	0.0231	-0.0610	-0.0579	0.0409	-0.0229	0.0718	0.00994
	(0.111)	(0.0377)	(0.110)	(0.0425)	(0.0856)	(0.0321)	(0.0661)	(0.0255)
Interview Month 12	0.0988	0.0422	-0.120	0.0149	0.0379	-0.0345	0.0108	-0.0313
	(0.0930)	(0.0383)	(0.0952)	(0.0435)	(0.0717)	(0.0331)	(0.0583)	(0.0250)
Farm Size Quantile 2	-0.530***	0.0289	-0.825***	-0.471***	-0.454***	-0.786***	-0.383***	-0.427***
	(0.159)	(0.0966)	(0.181)	(0.101)	(0.135)	(0.0797)	(0.103)	(0.0582)
Farm Size Quantile 3	-0.461***	0.131	-0.861***	-0.412***	-0.436***	-0.753***	-0.359***	-0.386***
	(0.158)	(0.0944)	(0.183)	(0.101)	(0.139)	(0.0808)	(0.107)	(0.0594)
Farm Size Quantile 4	-0.454***	0.153	-0.789***	-0.338***	-0.393***	-0.714***	-0.338***	-0.384***
	(0.161)	(0.0951)	(0.186)	(0.101)	(0.139)	(0.0818)	(0.106)	(0.0601)
Farm Size Quantile 5	-0.520***	0.136	-0.805***	-0.317***	-0.393***	-0.707***	-0.400***	-0.423***
	(0.162)	(0.0942)	(0.186)	(0.100)	(0.142)	(0.0811)	(0.108)	(0.0605)
Observations	16,365	16,365	16,365	16,365	16,365	16,365	16,365	16,365
R-squared	0.579	0.666	0.338	0.452	0.347	0.396	0.167	0.218
Number of HH	3,887		3,887		3,887		3,887	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16: Robustness 4 - Maize Regressions

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.489***	0.410***	0.489***	0.369***	0.257***	0.0928***	0.168***	0.0833***
	(0.0154)	(0.0276)	(0.0176)	(0.0315)	(0.0185)	(0.0338)	(0.0143)	(0.0242)
Plot Expense	-0.0185***	0.00125	-0.00541**	0.00938***	0.111***	0.112***	0.0498***	0.0392***
	(0.00208)	(0.00330)	(0.00234)	(0.00346)	(0.00240)	(0.00483)	(0.00181)	(0.00326)
Collective Plot	0.247***	0.325***	0.167**	0.210*	-0.139**	-0.128	-0.0884*	-0.151*
	(0.0626)	(0.0982)	(0.0649)	(0.118)	(0.0708)	(0.114)	(0.0482)	(0.0821)
Plot is Rented In	0.0209	0.0847	0.0952*	0.0178	-0.415***	-0.436***	-0.177***	-0.0834
	(0.0476)	(0.0701)	(0.0525)	(0.0761)	(0.0644)	(0.0978)	(0.0478)	(0.0645)
Irrigated	0.337***	0.283**	0.333***	0.0441	-0.00201	-0.243	-0.124	-0.177
	(0.0827)	(0.125)	(0.0894)	(0.171)	(0.0983)	(0.150)	(0.0830)	(0.123)
Plot Uses Organic Fert.	0.0110**	0.0285***	0.00898*	0.0108	-0.0155***	-0.0194**	-0.0148***	-0.00453
	(0.00437)	(0.00659)	(0.00511)	(0.00812)	(0.00601)	(0.00878)	(0.00449)	(0.00752)
Plot is Intercropped	0.0244	-0.00124	-0.00640	0.0351	-0.0702***	-0.0520*	-0.0530***	-0.0101
	(0.0211)	(0.0257)	(0.0229)	(0.0313)	(0.0236)	(0.0306)	(0.0180)	(0.0249)
Plot Used Improved Seeds	0.0107	-0.0118	-0.0344	-0.0823**	-0.224***	-0.258***	-0.0645***	-0.0919***
	(0.0231)	(0.0351)	(0.0255)	(0.0406)	(0.0277)	(0.0398)	(0.0213)	(0.0329)
Plot Dist to HH	0.00868***	0.0211***	0.00512*	0.0154***	0.0310***	0.0195***	0.0172***	0.00970***
	(0.00277)	(0.00427)	(0.00285)	(0.00454)	(0.00322)	(0.00474)	(0.00250)	(0.00332)
Area Planted All Other Plots	-0.116***	-0.112***	-0.0269*	-0.0698**	0.0594***	-0.0779***	0.0544***	-0.0407*
	(0.0143)	(0.0238)	(0.0154)	(0.0294)	(0.0165)	(0.0292)	(0.0130)	(0.0238)
Plot Value	0.0252***	0.0791***	0.0152*	0.0781***	0.0421***	0.0435**	0.0332***	0.0369***
	(0.00735)	(0.0137)	(0.00822)	(0.0163)	(0.00890)	(0.0170)	(0.00618)	(0.0104)
Value of All Other Plots	-0.00155	-0.00422	-0.00599**	-0.00466	-0.00235	0.00861	-0.00341*	-0.00238
	(0.00221)	(0.00474)	(0.00244)	(0.00523)	(0.00264)	(0.00568)	(0.00200)	(0.00459)
Mgrs. All Female	-0.146***	0.110	-0.135**	-0.0760	0.118**	-0.105	0.0196	-0.0409
	(0.0533)	(0.0886)	(0.0605)	(0.0905)	(0.0583)	(0.0820)	(0.0444)	(0.0589)
Mgs. Mixed Genders	-0.125**	-0.238**	-0.121*	-0.226*	0.0372	0.101	0.0517	0.162*
	(0.0626)	(0.100)	(0.0655)	(0.122)	(0.0733)	(0.118)	(0.0498)	(0.0849)
Observations	9,410	6,827	9,410	6,827	9,410	6,827	9,410	6,827
R-squared	0.338	0.273	0.287	0.200	0.369	0.320	0.227	0.159
Number of HH		2,109		2,109		2,109		2,109
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

Cluster-Robust standard errors in parentheses

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

Table 16: Robustness 4 - Maize Regressions

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg. Educ of Mgrs.	-0.0678***	0.0358	-0.0236	0.0565	0.0596***	0.0564	0.0319*	0.0342
	(0.0204)	(0.0391)	(0.0212)	(0.0412)	(0.0224)	(0.0405)	(0.0179)	(0.0300)
Avg. Age of Mgrs.	0.108	0.144	0.109	0.122	0.0143	0.0417	0.0775*	0.00252
	(0.0861)	(0.115)	(0.0852)	(0.107)	(0.0660)	(0.0878)	(0.0447)	(0.0642)
Avg. BMI of Mgrs.	-0.00408	-0.0523	-0.0111	-0.000345	0.0105	-0.0111	0.00285	-0.00638
	(0.0106)	(0.0328)	(0.0129)	(0.0356)	(0.0131)	(0.0322)	(0.0100)	(0.0323)
Mgr. is Head	0.0432	0.0430	0.0192	-0.0357	0.109	0.0853	-0.0634	0.00567
	(0.0716)	(0.104)	(0.0766)	(0.107)	(0.0722)	(0.102)	(0.0545)	(0.0778)
# Children	0.0461***	0.0273	0.0542***	0.0376*	-0.0272***	-0.00139	-0.0208***	-0.0175
	(0.00594)	(0.0176)	(0.00692)	(0.0210)	(0.00714)	(0.0199)	(0.00559)	(0.0143)
# Adult Members	0.100***	0.0949***	0.0878***	0.0991***	-0.0786***	-0.0159	-0.0581***	-0.0198
	(0.0106)	(0.0201)	(0.0115)	(0.0252)	(0.0114)	(0.0258)	(0.00829)	(0.0228)
# Seniors	-0.0238	0.0471	-0.0427	-0.00817	0.0375	-0.0669	0.00165	0.0482
	(0.0239)	(0.0683)	(0.0262)	(0.0679)	(0.0259)	(0.0708)	(0.0187)	(0.0565)
Pop density	-0.0612***	-0.00872	-0.0667***	0.0170	0.0266***	-0.00908	0.000806	-0.00188
	(0.00980)	(0.0146)	(0.0110)	(0.0180)	(0.00979)	(0.0166)	(0.00685)	(0.0132)
HH Assets	-0.0667***	-0.0127	-0.0376***	-0.0184	0.0574***	-0.00232	0.0359***	0.0146
	(0.00765)	(0.0134)	(0.00850)	(0.0153)	(0.00825)	(0.0142)	(0.00605)	(0.0116)
Farm Assets	0.00242	-0.00138	0.00911***	-0.000705	0.00238	0.00698	-0.00226	-0.00169
	(0.00237)	(0.00431)	(0.00262)	(0.00480)	(0.00276)	(0.00470)	(0.00209)	(0.00362)
Animal Units	-0.0397***	0.0626*	0.00777	0.0831**	0.0876***	-0.0713*	0.0465***	-0.00376
	(0.0122)	(0.0331)	(0.0135)	(0.0374)	(0.0156)	(0.0379)	(0.0123)	(0.0308)
Age HH Head	0.290***	0.202	0.154*	0.263	-0.111	0.0582	-0.160***	0.0353
	(0.0859)	(0.175)	(0.0877)	(0.183)	(0.0730)	(0.183)	(0.0511)	(0.135)
Educ. HH Head	0.0269	0.0128	0.00187	-0.0915**	-0.0528**	0.00239	-0.0285	0.0404
	(0.0193)	(0.0455)	(0.0195)	(0.0433)	(0.0212)	(0.0488)	(0.0176)	(0.0372)
Gender HH Head	-0.0361	0.0770	-0.00203	0.122	0.0603	-0.0891	-0.00749	0.0457
	(0.0462)	(0.112)	(0.0549)	(0.129)	(0.0493)	(0.122)	(0.0379)	(0.0935)
HH Death	0.0374	-0.0327	0.0734**	0.0375	0.0437	0.0344	0.0366	0.0763*
	(0.0322)	(0.0544)	(0.0355)	(0.0572)	(0.0367)	(0.0598)	(0.0284)	(0.0403)
Ag Wage	0.00664	0.0254	-0.00140	0.00158	-0.0282**	-0.0497***	-0.00683	0.00206
	(0.0112)	(0.0159)	(0.0130)	(0.0196)	(0.0131)	(0.0181)	(0.00984)	(0.0165)
Observations	9,410	6,827	9,410	6,827	9,410	6,827	9,410	6,827
R-squared	0.338	0.273	0.287	0.200	0.369	0.320	0.227	0.159
Number of HH		2,109		2,109		2,109		2,109
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 17: Robustness 4 - Paddy/Rice Regressions

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.313***	0.104	0.418***	0.170**	0.145***	0.199*	0.160***	0.0639
	(0.0384)	(0.0695)	(0.0503)	(0.0850)	(0.0479)	(0.106)	(0.0431)	(0.0899)
Plot Expense	-0.0269***	-0.0173**	-0.00938**	0.00675	0.139***	0.136***	0.0926***	0.0860***
	(0.00439)	(0.00689)	(0.00478)	(0.00814)	(0.00470)	(0.00930)	(0.00429)	(0.00858)
Collective Plot	0.170	0.177	0.352**	0.0175	0.130	-0.0428	0.0754	0.304*
	(0.152)	(0.175)	(0.138)	(0.209)	(0.147)	(0.231)	(0.139)	(0.162)
Plot is Rented In	-0.0102	-0.0347	0.188**	0.392**	-0.514***	-0.541*	-0.446***	-0.594*
	(0.0860)	(0.163)	(0.0916)	(0.186)	(0.126)	(0.312)	(0.106)	(0.318)
Plot is Irrigated	0.239**	0.0380	0.392***	0.0278	0.0974	0.239	-0.0389	0.282
	(0.115)	(0.150)	(0.123)	(0.182)	(0.137)	(0.298)	(0.124)	(0.213)
Organic Fert. Use	-0.0436**	0.00607	-0.0557**	-0.0101	-0.0283	-0.0639**	-0.00313	-0.0277
	(0.0221)	(0.0262)	(0.0217)	(0.0260)	(0.0214)	(0.0300)	(0.0203)	(0.0290)
Plot is Intercropped	0.146**	-0.209**	-0.00398	-0.0458	-0.173**	-0.142	-0.162**	-0.0569
	(0.0579)	(0.102)	(0.0717)	(0.136)	(0.0716)	(0.140)	(0.0663)	(0.121)
Plot Used Improved Seeds	0.0283	0.00909	-0.0931	-0.182*	-0.299***	-0.396***	-0.178***	-0.171*
	(0.0574)	(0.0785)	(0.0624)	(0.102)	(0.0711)	(0.111)	(0.0605)	(0.0968)
Plot Dist. to HH	0.00538	0.00648	0.00513	0.000533	0.00697	-0.0100	0.00932	-0.00347
	(0.00480)	(0.00887)	(0.00548)	(0.0121)	(0.00663)	(0.0136)	(0.00605)	(0.0122)
Area Planted to All Other Plots	-0.0921***	-0.207***	-0.00394	-0.0314	-0.0253	-0.0164	-0.0376	0.00792
	(0.0256)	(0.0529)	(0.0296)	(0.0732)	(0.0326)	(0.0766)	(0.0292)	(0.0659)
Plot Value	0.0218	0.0632*	0.0442**	0.116***	0.0886***	0.0513*	0.0548***	0.0855***
	(0.0220)	(0.0375)	(0.0189)	(0.0352)	(0.0171)	(0.0292)	(0.0169)	(0.0300)
Value of All Other Plots	0.0105**	0.0166	0.0137**	0.0153	-0.00271	0.0105	0.00285	0.0153
	(0.00523)	(0.0120)	(0.00577)	(0.0125)	(0.00647)	(0.0162)	(0.00545)	(0.0126)
Plot Mgrs. are All Female	-0.220**	-0.250	-0.143	-0.504***	0.210*	0.217	0.158	-0.0432
	(0.0971)	(0.178)	(0.113)	(0.193)	(0.120)	(0.209)	(0.108)	(0.205)
Plot Mgrs. are Mixed Gender	0.0554	-0.147	-0.112	0.158	-0.0763	0.144	-0.0513	-0.367**
	(0.158)	(0.187)	(0.143)	(0.220)	(0.150)	(0.247)	(0.139)	(0.177)
Observations	2,459	1,810	2,459	1,810	2,459	1,810	2,459	1,810
R-squared	0.299	0.282	0.306	0.312	0.450	0.417	0.362	0.372
Number of HH		785		785		785		785
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

Cluster-Robust standard errors in parentheses

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

Table 17: Robustness 4 - Paddy/Rice Regressions

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg Educ. of Mgrs.	-0.0398	-0.0321	0.0206	0.0212	0.0950**	0.101	0.0431	-0.0412
	(0.0340)	(0.0673)	(0.0390)	(0.0874)	(0.0445)	(0.0886)	(0.0416)	(0.0806)
Avg Age of Mgrs.	0.303***	0.147	0.280**	0.468**	-0.00573	0.0924	-0.0238	0.158
	(0.0989)	(0.195)	(0.132)	(0.214)	(0.110)	(0.228)	(0.134)	(0.263)
Avg BMI of Mgrs.	0.0359*	0.144*	0.00814	0.0263	-0.0708***	-0.0192	-0.0353	-0.119*
	(0.0217)	(0.0774)	(0.0229)	(0.0655)	(0.0266)	(0.0881)	(0.0235)	(0.0651)
Mgr is Head	-0.272**	-0.212	-0.181	-0.331	0.0526	-0.122	-0.0106	-0.246
	(0.107)	(0.213)	(0.121)	(0.244)	(0.134)	(0.254)	(0.135)	(0.305)
# Children	0.0441***	0.00879	0.0522***	0.0430	-0.0520***	-0.00919	-0.0282**	-0.00744
	(0.0107)	(0.0376)	(0.0120)	(0.0395)	(0.0143)	(0.0489)	(0.0125)	(0.0388)
# Adult Members	0.0980***	0.108**	0.123***	0.120**	-0.0562**	-0.0439	-0.0523***	0.0623
	(0.0192)	(0.0461)	(0.0200)	(0.0547)	(0.0229)	(0.0649)	(0.0196)	(0.0530)
# Seniors	-0.0687	0.0194	-0.0389	-0.185	-0.0125	0.00553	0.00847	-0.200
	(0.0456)	(0.142)	(0.0552)	(0.145)	(0.0559)	(0.157)	(0.0508)	(0.133)
Pop Density (persons per km^2)	-0.0563***	-0.0327	-0.0133	0.0728**	0.0625***	0.0946**	0.0192	0.00282
	(0.0168)	(0.0266)	(0.0187)	(0.0301)	(0.0203)	(0.0400)	(0.0177)	(0.0332)
HH Assets	-0.0476***	-0.0397*	-0.0398***	0.0229	0.0705***	-0.00552	0.0278*	-0.0285
	(0.0141)	(0.0241)	(0.0151)	(0.0300)	(0.0163)	(0.0335)	(0.0142)	(0.0263)
Farm Assets	-0.000574	-0.00800	0.00571	0.00413	0.00868	0.0252**	0.00359	0.00125
	(0.00473)	(0.00764)	(0.00508)	(0.00909)	(0.00587)	(0.0115)	(0.00515)	(0.00929)
Animal Units	0.00838	0.0906	0.0427	-0.0558	0.0234	-0.0798	0.0620**	-0.0566
	(0.0225)	(0.0597)	(0.0263)	(0.0678)	(0.0292)	(0.0853)	(0.0263)	(0.0694)
Age HH Head	-0.0740	0.341	-0.199	-0.422	0.124	-0.253	-0.145	-0.314
	(0.129)	(0.337)	(0.152)	(0.404)	(0.146)	(0.539)	(0.156)	(0.561)
Educ of HH Head	-0.0323	0.0263	0.0152	-0.0425	-0.0570	-0.0269	-0.0525	0.0980
	(0.0337)	(0.0803)	(0.0382)	(0.102)	(0.0449)	(0.115)	(0.0409)	(0.0870)
Gender HH Head	-0.127	-0.137	-0.0782	-0.270	0.112	-0.102	0.0509	-0.102
	(0.0803)	(0.190)	(0.0983)	(0.240)	(0.105)	(0.269)	(0.0939)	(0.277)
HH Experienced a Death	0.101	0.310***	0.0433	-0.236**	0.0649	-0.262*	-0.114	-0.104
	(0.0668)	(0.117)	(0.0734)	(0.119)	(0.0833)	(0.147)	(0.0763)	(0.114)
Ag Wage	-0.00381	0.0582*	-0.00996	0.0565	0.0585**	0.0577	0.0472**	0.0278
	(0.0191)	(0.0334)	(0.0244)	(0.0358)	(0.0238)	(0.0413)	(0.0212)	(0.0363)
Observations	2,459	1,810	2,459	1,810	2,459	1,810	2,459	1,810
R-squared	0.299	0.282	0.306	0.312	0.450	0.417	0.362	0.372
Number of HH		785		785		785		785
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 18: Robustness 4 - Legumes

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.458***	0.317***	0.451***	0.282***	0.257***	0.163***	0.145***	0.161***
	(0.0197)	(0.0472)	(0.0231)	(0.0494)	(0.0255)	(0.0502)	(0.0192)	(0.0431)
Plot Expense	-0.0172***	0.00769	-0.00345	0.00689	0.112***	0.112***	0.0484***	0.0305***
	(0.00317)	(0.00506)	(0.00351)	(0.00558)	(0.00372)	(0.00718)	(0.00279)	(0.00481)
Collective Plot	0.248***	0.258	0.135	-0.0785	-0.115	0.0484	-0.112	-0.0971
	(0.0852)	(0.174)	(0.0961)	(0.143)	(0.0996)	(0.192)	(0.0707)	(0.119)
Plot is Rented In	-0.128	0.0113	-0.0839	-0.155	-0.293***	-0.559***	-0.0591	-0.189
	(0.0792)	(0.155)	(0.0789)	(0.131)	(0.101)	(0.171)	(0.0803)	(0.146)
Plot is Irrigated	0.402***	-0.0214	-0.0202	-0.273	0.152	0.246	0.0997	-0.0118
	(0.148)	(0.273)	(0.146)	(0.241)	(0.168)	(0.358)	(0.134)	(0.276)
Organic Fert. Use	0.0216***	0.0433***	0.0106	0.0213	-0.0235**	-0.0124	-0.0219***	-0.0184
	(0.00642)	(0.0109)	(0.00766)	(0.0143)	(0.00919)	(0.0158)	(0.00681)	(0.0136)
Plot is Intercropped	-0.0169	-0.0693	-0.0814*	-0.186**	0.00652	-0.00134	-0.102**	-0.0709
	(0.0430)	(0.0684)	(0.0476)	(0.0811)	(0.0526)	(0.0860)	(0.0413)	(0.0695)
Plot Used Improved Seeds	0.0505	-0.0728	0.00516	-0.00470	-0.248***	-0.316***	-0.0714**	-0.135**
	(0.0343)	(0.0605)	(0.0380)	(0.0674)	(0.0435)	(0.0697)	(0.0331)	(0.0613)
Plot Dist. to HH	0.00443	0.0157***	0.00156	-0.000454	0.0267***	0.0247***	0.0176***	0.0106*
	(0.00399)	(0.00581)	(0.00427)	(0.00683)	(0.00486)	(0.00752)	(0.00372)	(0.00575)
Area Planted to All Other Plots	-0.0942***	-0.168***	-0.0403*	-0.147***	0.0801***	0.00569	0.0915***	0.00118
	(0.0213)	(0.0397)	(0.0222)	(0.0473)	(0.0250)	(0.0483)	(0.0196)	(0.0410)
Plot Value	0.0224**	0.0312	0.0235**	0.0546**	0.0296**	0.0431*	0.0237***	0.0213
	(0.00983)	(0.0211)	(0.0114)	(0.0263)	(0.0119)	(0.0237)	(0.00787)	(0.0171)
Value All Other Plots	0.000551	-0.00569	-0.000407	0.0139*	-0.00394	0.0132	-0.00454*	-0.0102
	(0.00314)	(0.00682)	(0.00344)	(0.00821)	(0.00369)	(0.00918)	(0.00276)	(0.00717)
Plot Mgrs. All Female	-0.283***	-0.0649	-0.294***	-0.0764	0.156*	-0.235	0.0496	-0.0696
	(0.0763)	(0.146)	(0.0865)	(0.147)	(0.0893)	(0.176)	(0.0607)	(0.102)
Plot Mgrs. Mixed Genders	-0.181**	-0.191	-0.139	-0.0637	0.0717	-0.0228	0.0459	0.0874
	(0.0864)	(0.169)	(0.0970)	(0.146)	(0.105)	(0.195)	(0.0731)	(0.117)
Observations	4,455	3,164	4,455	3,164	4,455	3,164	4,455	3,164
R-squared	0.341	0.286	0.295	0.228	0.349	0.361	0.226	0.187
Number of HH		1,482		1,482		1,482		1,482
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

Cluster-Robust standard errors in parentheses

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

Table 18: Robustness 4 - Legumes

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg. Educ of Mgrs.	-0.0414	0.00749	-0.0450	0.0635	0.0574*	0.0379	0.0707***	0.00305
	(0.0286)	(0.0624)	(0.0320)	(0.0613)	(0.0340)	(0.0673)	(0.0272)	(0.0582)
Avg. Age of Mgrs.	0.224**	0.293	0.249**	-0.0699	-0.00780	0.0459	0.0462	0.00569
	(0.103)	(0.201)	(0.109)	(0.199)	(0.0873)	(0.155)	(0.0544)	(0.114)
Avg. BMI of Mgrs.	0.00404	0.0174	0.00482	0.0306	0.00731	0.0699	-0.00765	0.0464
	(0.0159)	(0.0556)	(0.0186)	(0.0637)	(0.0223)	(0.0577)	(0.0160)	(0.0717)
Mgr. is Head	-0.113	0.0574	-0.0689	0.349**	0.191*	-0.0138	0.0481	-0.0924
	(0.0940)	(0.149)	(0.105)	(0.173)	(0.104)	(0.201)	(0.0670)	(0.126)
# Children	0.0444***	-0.0184	0.0626***	0.0143	-0.0125	0.0420	-0.00653	-0.0138
	(0.00898)	(0.0290)	(0.0104)	(0.0385)	(0.0114)	(0.0349)	(0.00864)	(0.0287)
# Adult Members	0.0927***	0.151***	0.0829***	0.108**	-0.104***	-0.110**	-0.0650***	-0.0288
	(0.0155)	(0.0400)	(0.0166)	(0.0538)	(0.0176)	(0.0452)	(0.0130)	(0.0360)
# Seniors	-0.0272	0.0121	-0.0319	0.00639	-0.00337	-0.353***	-0.0151	-0.0451
	(0.0353)	(0.0983)	(0.0392)	(0.121)	(0.0400)	(0.114)	(0.0293)	(0.105)
Pop Density (persons per km^2)	-0.0630***	-0.0462**	-0.0738***	0.00926	-0.00650	0.00436	0.00893	-0.00477
	(0.0148)	(0.0223)	(0.0171)	(0.0277)	(0.0152)	(0.0292)	(0.0102)	(0.0236)
HH Assets	-0.0680***	-0.00407	-0.0320**	-0.0357	0.0760***	0.00462	0.0467***	-0.00564
	(0.0110)	(0.0218)	(0.0125)	(0.0270)	(0.0132)	(0.0280)	(0.00950)	(0.0183)
Farm Assets	0.00580*	0.00183	0.0108***	-0.00468	-0.00347	-0.00244	-0.00543*	-0.00587
	(0.00351)	(0.00754)	(0.00389)	(0.00875)	(0.00419)	(0.00855)	(0.00306)	(0.00595)
Animal Units	-0.0745***	0.0498	-0.0282	0.134**	0.0633**	-0.176**	0.0659***	0.0203
	(0.0191)	(0.0548)	(0.0209)	(0.0665)	(0.0259)	(0.0700)	(0.0201)	(0.0472)
Age of HH Head	0.146	0.405	0.0719	0.458*	-0.0128	0.158	-0.0998	0.114
	(0.107)	(0.272)	(0.115)	(0.270)	(0.101)	(0.309)	(0.0690)	(0.211)
Years of Educ. of HH Head	0.0137	0.0229	0.0324	-0.0635	-0.0759**	-0.00162	-0.0842***	0.00439
	(0.0266)	(0.0652)	(0.0293)	(0.0761)	(0.0321)	(0.0861)	(0.0268)	(0.0709)
Gender of HH Head	-0.112*	0.0345	-0.124	0.150	0.154**	-0.436*	0.0206	-0.0429
	(0.0643)	(0.167)	(0.0765)	(0.204)	(0.0746)	(0.254)	(0.0500)	(0.133)
HH Experienced a Death	-0.00226	-0.116	0.0980*	0.111	0.0797	0.182*	0.0660	0.101
	(0.0478)	(0.0844)	(0.0543)	(0.104)	(0.0552)	(0.0954)	(0.0436)	(0.0827)
Ag Wage	0.000623	0.0393	-0.00503	-0.0108	-0.00804	-0.00822	0.0186	0.0501*
	(0.0162)	(0.0240)	(0.0199)	(0.0289)	(0.0172)	(0.0261)	(0.0119)	(0.0259)
Observations	4,455	3,164	4,455	3,164	4,455	3,164	4,455	3,164
R-squared	0.341	0.286	0.295	0.228	0.349	0.361	0.226	0.187
Number of HH		1,482		1,482		1,482		1,482
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 19: Robustness 4 - Sweet Potatoes

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.336***	0.369***	0.244***	0.171	0.208***	0.105	0.0942***	0.216**
	(0.0381)	(0.134)	(0.0492)	(0.222)	(0.0480)	(0.142)	(0.0351)	(0.0893)
Plot Expense	-0.00591	-0.0153	0.00181	0.0104	0.120***	0.130***	0.0429***	0.0379**
	(0.00598)	(0.0172)	(0.00802)	(0.0267)	(0.00825)	(0.0282)	(0.00565)	(0.0192)
Collective Plot	-0.0583	0.262	0.143	0.387	-0.0624	-0.354	-0.0203	-0.550**
	(0.204)	(0.356)	(0.226)	(0.500)	(0.181)	(0.355)	(0.151)	(0.263)
Plot is Rented In	0.186	-0.0958	0.197	-0.968**	-0.630***	-0.616	-0.366***	-0.387
	(0.135)	(0.233)	(0.215)	(0.426)	(0.214)	(0.521)	(0.0957)	(0.245)
Plot Irrigated	0.0934	-0.934**	-0.0355	2.403***	0.553**	0.227	0.275**	-0.841**
	(0.239)	(0.462)	(0.400)	(0.669)	(0.277)	(0.791)	(0.118)	(0.393)
Organic Fert. Use	0.00779	0.0322*	0.00312	0.0168	-0.0244	-0.0372	-0.0132	-0.0307
	(0.0116)	(0.0173)	(0.0162)	(0.0402)	(0.0175)	(0.0454)	(0.0130)	(0.0287)
Intercropped	0.165***	0.336**	-0.104	0.375	-0.0174	-0.0631	0.0267	-0.00892
	(0.0577)	(0.134)	(0.0820)	(0.249)	(0.0736)	(0.230)	(0.0504)	(0.157)
Plot Used Improved Seeds	-0.0107	0.0744	-0.0483	0.354	-0.437***	-0.476*	-0.115*	-0.167
	(0.0704)	(0.148)	(0.0912)	(0.226)	(0.100)	(0.268)	(0.0695)	(0.223)
Plot Dist. to HH	0.00137	0.0350*	0.00513	0.00920	0.0479***	0.0565**	0.0267**	0.00209
	(0.0114)	(0.0186)	(0.0137)	(0.0279)	(0.0124)	(0.0282)	(0.0104)	(0.0208)
Area Planted to Other Plots	-0.0314	-0.187*	-0.00984	-0.0495	0.0323	0.00240	0.0175	0.274***
	(0.0360)	(0.102)	(0.0491)	(0.179)	(0.0442)	(0.112)	(0.0347)	(0.0869)
Plot Value	0.0975***	-0.0581	0.0610**	-0.0265	0.0703***	0.0307	0.0335*	0.0176
	(0.0218)	(0.0558)	(0.0281)	(0.0605)	(0.0243)	(0.0516)	(0.0175)	(0.0265)
Value All Other Plots	-0.0153***	0.0119	-0.00380	-0.00700	0.00978	-0.00195	0.00144	-0.0331*
	(0.00532)	(0.0193)	(0.00780)	(0.0271)	(0.00707)	(0.0233)	(0.00504)	(0.0181)
All Managers Female	-0.0843	-0.625*	0.00612	-1.801***	0.308*	0.536	-0.00126	1.207***
	(0.137)	(0.368)	(0.204)	(0.495)	(0.173)	(0.379)	(0.138)	(0.274)
Managers are Mixed Genders	0.145	-0.164	-0.0389	-0.378	0.195	0.477	-0.0432	0.478*
	(0.199)	(0.338)	(0.235)	(0.584)	(0.185)	(0.375)	(0.147)	(0.262)
Observations	1,134	700	1,134	700	1,134	700	1,134	700
R-squared	0.536	0.709	0.353	0.574	0.449	0.623	0.318	0.576
Number of HH		482		482		482		482
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 19: Robustness 4 - Sweet Potatoes

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg Educ of Mgrs.	-0.0553	0.0804	-0.0443	-0.617***	0.0782	0.0579	0.0233	0.311**
	(0.0549)	(0.132)	(0.0789)	(0.219)	(0.0619)	(0.205)	(0.0487)	(0.123)
Avg Age of Mgrs.	0.501*	0.159	0.755***	-0.392	0.205	0.219	0.229*	-0.664
	(0.268)	(0.886)	(0.259)	(1.144)	(0.189)	(1.079)	(0.134)	(0.567)
Avg BMI of Mgrs.	-0.0483**	-0.00906	-0.0913**	-0.0680	-0.0168	-0.144	0.0141	0.0158
	(0.0226)	(0.142)	(0.0379)	(0.205)	(0.0451)	(0.230)	(0.0368)	(0.104)
Mgr is Head	-0.0890	-0.245	-0.237	-2.310***	0.326*	-0.313	-0.00335	1.020***
	(0.150)	(0.400)	(0.233)	(0.548)	(0.197)	(0.400)	(0.181)	(0.266)
# Children	0.0175	0.0136	0.0292	0.0366	-0.0384**	0.00105	-0.00605	0.0126
	(0.0153)	(0.0483)	(0.0199)	(0.0727)	(0.0174)	(0.0805)	(0.0140)	(0.0368)
# Adult Members	0.0826***	0.143***	0.0924***	0.102	-0.0378	-0.0949	-0.0398**	0.0936**
	(0.0237)	(0.0464)	(0.0266)	(0.0671)	(0.0282)	(0.0705)	(0.0191)	(0.0429)
# Seniors	-0.0577	-0.157	-0.102	-0.0757	0.0351	0.0477	0.0544	0.0577
	(0.0637)	(0.230)	(0.0798)	(0.288)	(0.0741)	(0.331)	(0.0560)	(0.212)
Pop Density (persons per km^2)	-0.0629***	-0.159***	-0.0378	0.0238	-0.0232	-0.0699	-0.0150	-0.0427
	(0.0218)	(0.0445)	(0.0325)	(0.0854)	(0.0214)	(0.0683)	(0.0129)	(0.0398)
HH Assets	-0.0671***	0.0244	0.0165	0.286***	0.0384	0.218**	0.0320	0.0534
	(0.0260)	(0.0620)	(0.0314)	(0.0899)	(0.0291)	(0.102)	(0.0210)	(0.0504)
Farm Assets	0.0233***	0.00885	0.00785	-0.0413	-0.00230	-0.0186	-0.00148	-0.00390
	(0.00771)	(0.0175)	(0.00909)	(0.0271)	(0.00814)	(0.0274)	(0.00564)	(0.0182)
Animal Units	0.0238	0.176**	0.0413	-0.159	0.0351	-0.0247	0.0583**	0.131*
	(0.0259)	(0.0686)	(0.0352)	(0.114)	(0.0348)	(0.146)	(0.0286)	(0.0718)
Age of HH Head	-0.213	-0.720	-0.543**	-0.353	-0.222	0.902	-0.386***	1.331*
	(0.257)	(0.856)	(0.264)	(1.161)	(0.220)	(1.034)	(0.149)	(0.711)
Years of Educ of HH head	-0.00813	-0.127	0.00146	0.500**	-0.0494	-0.0346	-0.0150	0.0548
	(0.0517)	(0.144)	(0.0787)	(0.212)	(0.0601)	(0.180)	(0.0445)	(0.108)
Gender of HH head	0.0586	-0.769**	0.0900	-0.717	-0.0181	0.426	-0.111	0.420
	(0.118)	(0.357)	(0.186)	(0.563)	(0.151)	(0.390)	(0.121)	(0.310)
HH Experienced a Death	-0.0954	0.469**	0.146	0.114	-0.00715	0.473**	0.0169	0.446***
	(0.0789)	(0.202)	(0.101)	(0.240)	(0.0943)	(0.220)	(0.0715)	(0.148)
Ag Wage	-0.00366	-0.134**	-0.00155	-0.0378	0.0679**	0.0440	0.00924	-0.0156
	(0.0293)	(0.0519)	(0.0429)	(0.0812)	(0.0324)	(0.0831)	(0.0211)	(0.0498)
Observations	1,134	700	1,134	700	1,134	700	1,134	700
R-squared	0.536	0.709	0.353	0.574	0.449	0.623	0.318	0.576
Number of HH		482		482		482		482
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 20: Robustness 4 - Cotton

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.209***	0.433***	0.218**	0.234	0.243**	0.237	0.334***	0.647***
	(0.0639)	(0.0987)	(0.0880)	(0.158)	(0.116)	(0.243)	(0.0914)	(0.233)
Plot Expense	-0.00408	-0.0303	-0.000353	0.00376	0.204***	0.161***	0.164***	0.0790*
	(0.0185)	(0.0247)	(0.0240)	(0.0287)	(0.0283)	(0.0501)	(0.0217)	(0.0401)
Collective Plot	0.666***	-0.0749	0.531*	-0.139	-0.336	-0.113	-0.166	-0.431
	(0.237)	(0.261)	(0.309)	(0.311)	(0.342)	(0.606)	(0.272)	(0.405)
Plot is Rented In	-0.000907	0.301	0.331	0.445*	-0.303	0.214	-0.359*	-0.224
	(0.166)	(0.212)	(0.201)	(0.260)	(0.231)	(0.369)	(0.210)	(0.383)
Irrigated	-0.216		-1.158***		1.962***		1.555***	
	(0.254)		(0.375)		(0.428)		(0.364)	
Organic Fert. Use	0.0331	0.0337	0.0202	0.0329	0.0124	-0.0181	0.0536*	-0.0467
	(0.0208)	(0.0419)	(0.0264)	(0.0601)	(0.0327)	(0.0614)	(0.0305)	(0.0641)
Plot is Intercropped	-0.0830	-0.150	-0.124	0.192	0.245	-0.470**	0.0123	-0.261
	(0.0997)	(0.131)	(0.130)	(0.174)	(0.159)	(0.236)	(0.133)	(0.262)
Plot Used Improved Seeds	-0.0439	0.00884	-0.120	-0.417**	0.0493	0.0799	-0.0511	0.114
	(0.0965)	(0.146)	(0.146)	(0.182)	(0.161)	(0.293)	(0.139)	(0.367)
Plot Dist to HH	-0.0104	0.0152	-0.0469**	-0.0736*	0.0512**	0.0399	0.0467**	0.0215
	(0.0174)	(0.0264)	(0.0230)	(0.0383)	(0.0227)	(0.0487)	(0.0222)	(0.0403)
Area Planted to All Other Plots	-0.104	-0.0143	-0.0689	0.0594	0.0620	-0.298	0.0728	0.152
	(0.0640)	(0.0935)	(0.0770)	(0.120)	(0.0933)	(0.203)	(0.0799)	(0.201)
Plot Value	0.138**	0.136**	0.142**	0.0784	0.126	0.0118	0.00656	-0.144
	(0.0534)	(0.0580)	(0.0682)	(0.135)	(0.0775)	(0.133)	(0.0601)	(0.119)
Value of All Other Plots	-0.0149	0.00542	-0.00478	-0.0129	0.0230	0.0239	0.00806	-0.0243
	(0.0115)	(0.0246)	(0.0143)	(0.0260)	(0.0177)	(0.0355)	(0.0147)	(0.0372)
Managers are All Female	-0.462**	-0.195	-0.271	-0.545	0.118	0.740	-0.119	0.771*
	(0.225)	(0.250)	(0.281)	(0.363)	(0.306)	(0.519)	(0.253)	(0.417)
Managers are Mixed Gender	-0.647***	-0.105	-0.432	-0.0513	0.107	0.0947	-0.251	0.575
	(0.233)	(0.243)	(0.327)	(0.321)	(0.351)	(0.607)	(0.279)	(0.489)
Observations	497	306	497	306	497	306	497	306
R-squared	0.505	0.735	0.404	0.648	0.446	0.595	0.481	0.515
Number of HH		134		134		134		134
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 20: Robustness 4 - Cotton

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg. Years of Educ of Mgrs.	-0.0990	0.266*	-0.208*	-0.0384	0.00714	0.0999	-0.0376	-0.0569
	(0.0820)	(0.152)	(0.113)	(0.228)	(0.123)	(0.201)	(0.122)	(0.218)
Avg. Age of Mgrs.	1.006**	0.644	1.606***	1.482*	-0.100	-0.394	-0.0385	-1.295*
	(0.439)	(0.478)	(0.454)	(0.863)	(0.561)	(0.969)	(0.523)	(0.739)
Avg. BMI of Mgrs.	0.00964	0.194*	-0.00626	0.0921	-0.157**	-0.237	-0.0692	-0.310*
	(0.0514)	(0.111)	(0.0517)	(0.137)	(0.0606)	(0.145)	(0.0502)	(0.184)
Mgr is Head	-0.259	-0.266	-0.575*	-0.910*	0.470	0.803	-0.113	0.968**
	(0.231)	(0.349)	(0.312)	(0.484)	(0.362)	(0.633)	(0.300)	(0.458)
# children	0.0269	0.0475	0.0270	-0.00565	-0.0271	-0.469***	-0.0225	-0.116
	(0.0180)	(0.0703)	(0.0259)	(0.0699)	(0.0322)	(0.147)	(0.0263)	(0.107)
# Adult Members	0.0931***	-0.0108	0.142***	0.0737	-0.115**	0.159	-0.0998**	-0.0986
	(0.0287)	(0.0662)	(0.0446)	(0.0657)	(0.0535)	(0.137)	(0.0405)	(0.112)
# Seniors	0.0124	0.334	-0.0884	0.00438	0.0725	0.853	-0.0997	0.959*
	(0.0777)	(0.369)	(0.111)	(0.473)	(0.138)	(0.570)	(0.109)	(0.525)
Pop Density (persons per km^2)	0.0618	0.0189	0.0746	0.290*	0.0527	0.446**	0.0886	0.247
	(0.0859)	(0.139)	(0.114)	(0.161)	(0.0939)	(0.201)	(0.0843)	(0.187)
HH Assets	-0.0534	-0.0801	-0.0717	0.0825	0.0432	-0.0326	0.0407	0.0125
	(0.0468)	(0.0997)	(0.0625)	(0.112)	(0.0668)	(0.122)	(0.0600)	(0.140)
Farm Assets	0.0119	0.00746	0.0293	-0.0363	-0.0251	-0.00985	-0.0202	-0.0150
	(0.0130)	(0.0323)	(0.0222)	(0.0382)	(0.0241)	(0.0349)	(0.0215)	(0.0355)
Animal Units	0.0143	0.00844	-0.0400	0.0255	0.0816	0.0860	0.104*	-0.00398
	(0.0454)	(0.0966)	(0.0621)	(0.114)	(0.0692)	(0.131)	(0.0609)	(0.163)
Age HH head	-0.559	-1.206*	-1.246**	-1.451	-0.308	0.955	-0.430	1.200
	(0.452)	(0.662)	(0.490)	(0.976)	(0.574)	(0.981)	(0.550)	(1.117)
Educ of HH Head	0.00513	-0.596**	-0.00150	-0.679**	0.148	-0.0645	0.161	0.160
	(0.0857)	(0.232)	(0.119)	(0.282)	(0.128)	(0.457)	(0.128)	(0.402)
Gender HH Head	-0.139	0.434	-0.258	0.368	-0.142	2.000*	-0.0372	1.933**
	(0.185)	(0.515)	(0.239)	(0.630)	(0.241)	(1.023)	(0.197)	(0.748)
HH Death	-0.0779	-0.0449	-0.0867	0.317	-0.0451	0.996**	0.112	0.943**
	(0.133)	(0.224)	(0.193)	(0.270)	(0.212)	(0.428)	(0.175)	(0.444)
Ag Wage	-0.0136	-0.0262	-0.0914	0.117	0.0285	-0.230	0.0425	-0.122
	(0.0657)	(0.0644)	(0.0766)	(0.102)	(0.0811)	(0.162)	(0.0880)	(0.139)
Observations	497	306	497	306	497	306	497	306
R-squared	0.505	0.735	0.404	0.648	0.446	0.595	0.481	0.515
Number of HH		134		134		134		134
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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

Table 21: Robustness 4 - Tobacco

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Area Planted	0.209***	0.433***	0.218**	0.234	0.243**	0.237	0.334***	0.647***
	(0.0639)	(0.0987)	(0.0880)	(0.158)	(0.116)	(0.243)	(0.0914)	(0.233)
Plot Expense	-0.00408	-0.0303	-0.000353	0.00376	0.204***	0.161***	0.164***	0.0790*
	(0.0185)	(0.0247)	(0.0240)	(0.0287)	(0.0283)	(0.0501)	(0.0217)	(0.0401)
Collective Plot	0.666***	-0.0749	0.531*	-0.139	-0.336	-0.113	-0.166	-0.431
	(0.237)	(0.261)	(0.309)	(0.311)	(0.342)	(0.606)	(0.272)	(0.405)
Plot Rented In	-0.000907	0.301	0.331	0.445*	-0.303	0.214	-0.359*	-0.224
	(0.166)	(0.212)	(0.201)	(0.260)	(0.231)	(0.369)	(0.210)	(0.383)
Irrigated	-0.216		-1.158***		1.962***		1.555***	
	(0.254)		(0.375)		(0.428)		(0.364)	
Organic Fert Use	0.0331	0.0337	0.0202	0.0329	0.0124	-0.0181	0.0536*	-0.0467
	(0.0208)	(0.0419)	(0.0264)	(0.0601)	(0.0327)	(0.0614)	(0.0305)	(0.0641)
Plot is Intercropped	-0.0830	-0.150	-0.124	0.192	0.245	-0.470**	0.0123	-0.261
	(0.0997)	(0.131)	(0.130)	(0.174)	(0.159)	(0.236)	(0.133)	(0.262)
Improved Seeds Used	-0.0439	0.00884	-0.120	-0.417**	0.0493	0.0799	-0.0511	0.114
	(0.0965)	(0.146)	(0.146)	(0.182)	(0.161)	(0.293)	(0.139)	(0.367)
Plot Dist. to HH	-0.0104	0.0152	-0.0469**	-0.0736*	0.0512**	0.0399	0.0467**	0.0215
	(0.0174)	(0.0264)	(0.0230)	(0.0383)	(0.0227)	(0.0487)	(0.0222)	(0.0403)
Area Planted All Other Plots	-0.104	-0.0143	-0.0689	0.0594	0.0620	-0.298	0.0728	0.152
	(0.0640)	(0.0935)	(0.0770)	(0.120)	(0.0933)	(0.203)	(0.0799)	(0.201)
Plot Value	0.138**	0.136**	0.142**	0.0784	0.126	0.0118	0.00656	-0.144
	(0.0534)	(0.0580)	(0.0682)	(0.135)	(0.0775)	(0.133)	(0.0601)	(0.119)
Value All Other Plots	-0.0149	0.00542	-0.00478	-0.0129	0.0230	0.0239	0.00806	-0.0243
	(0.0115)	(0.0246)	(0.0143)	(0.0260)	(0.0177)	(0.0355)	(0.0147)	(0.0372)
All Female Mgrs	-0.462**	-0.195	-0.271	-0.545	0.118	0.740	-0.119	0.771*
	(0.225)	(0.250)	(0.281)	(0.363)	(0.306)	(0.519)	(0.253)	(0.417)
Mixed-Gender Mgrs.	-0.647***	-0.105	-0.432	-0.0513	0.107	0.0947	-0.251	0.575
	(0.233)	(0.243)	(0.327)	(0.321)	(0.351)	(0.607)	(0.279)	(0.489)
Observations	497	306	497	306	497	306	497	306
R-squared	0.505	0.735	0.404	0.648	0.446	0.595	0.481	0.515
Number of HH		134		134		134		134
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

Cluster-Robust standard errors in parentheses

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

Table 21: Robustness 4 - Tobacco

VARIABLES	(1) prep_labor	(2) prep_labor	(3) harv_labor	(4) harv_labor	(5) hired_prep_labor	(6) hired_prep_labor	(7) hired_harv_labor	(8) hired_harv_labor
Avg. Educ of Mgr.	-0.0990	0.266*	-0.208*	-0.0384	0.00714	0.0999	-0.0376	-0.0569
	(0.0820)	(0.152)	(0.113)	(0.228)	(0.123)	(0.201)	(0.122)	(0.218)
Avg. Age of Mgr.	1.006**	0.644	1.606***	1.482*	-0.100	-0.394	-0.0385	-1.295*
	(0.439)	(0.478)	(0.454)	(0.863)	(0.561)	(0.969)	(0.523)	(0.739)
Avg. BMI of Mgr.	0.00964	0.194*	-0.00626	0.0921	-0.157**	-0.237	-0.0692	-0.310*
	(0.0514)	(0.111)	(0.0517)	(0.137)	(0.0606)	(0.145)	(0.0502)	(0.184)
Mgr. is Head	-0.259	-0.266	-0.575*	-0.910*	0.470	0.803	-0.113	0.968**
	(0.231)	(0.349)	(0.312)	(0.484)	(0.362)	(0.633)	(0.300)	(0.458)
# Children in HH	0.0269	0.0475	0.0270	-0.00565	-0.0271	-0.469***	-0.0225	-0.116
	(0.0180)	(0.0703)	(0.0259)	(0.0699)	(0.0322)	(0.147)	(0.0263)	(0.107)
# Adults in HH	0.0931***	-0.0108	0.142***	0.0737	-0.115**	0.159	-0.0998**	-0.0986
	(0.0287)	(0.0662)	(0.0446)	(0.0657)	(0.0535)	(0.137)	(0.0405)	(0.112)
# Seniors in HH	0.0124	0.334	-0.0884	0.00438	0.0725	0.853	-0.0997	0.959*
	(0.0777)	(0.369)	(0.111)	(0.473)	(0.138)	(0.570)	(0.109)	(0.525)
Pop. Density (persons per km^2	0.0618	0.0189	0.0746	0.290*	0.0527	0.446**	0.0886	0.247
	(0.0859)	(0.139)	(0.114)	(0.161)	(0.0939)	(0.201)	(0.0843)	(0.187)
HH Assets	-0.0534	-0.0801	-0.0717	0.0825	0.0432	-0.0326	0.0407	0.0125
	(0.0468)	(0.0997)	(0.0625)	(0.112)	(0.0668)	(0.122)	(0.0600)	(0.140)
Farm Assets	0.0119	0.00746	0.0293	-0.0363	-0.0251	-0.00985	-0.0202	-0.0150
	(0.0130)	(0.0323)	(0.0222)	(0.0382)	(0.0241)	(0.0349)	(0.0215)	(0.0355)
Animal Units	0.0143	0.00844	-0.0400	0.0255	0.0816	0.0860	0.104*	-0.00398
	(0.0454)	(0.0966)	(0.0621)	(0.114)	(0.0692)	(0.131)	(0.0609)	(0.163)
Age HH Head	-0.559	-1.206*	-1.246**	-1.451	-0.308	0.955	-0.430	1.200
	(0.452)	(0.662)	(0.490)	(0.976)	(0.574)	(0.981)	(0.550)	(1.117)
Educ HH Head	0.00513	-0.596**	-0.00150	-0.679**	0.148	-0.0645	0.161	0.160
	(0.0857)	(0.232)	(0.119)	(0.282)	(0.128)	(0.457)	(0.128)	(0.402)
Gender HH Head	-0.139	0.434	-0.258	0.368	-0.142	2.000*	-0.0372	1.933**
	(0.185)	(0.515)	(0.239)	(0.630)	(0.241)	(1.023)	(0.197)	(0.748)
HH Death	-0.0779	-0.0449	-0.0867	0.317	-0.0451	0.996**	0.112	0.943**
	(0.133)	(0.224)	(0.193)	(0.270)	(0.212)	(0.428)	(0.175)	(0.444)
Ag Wage	-0.0136	-0.0262	-0.0914	0.117	0.0285	-0.230	0.0425	-0.122
	(0.0657)	(0.0644)	(0.0766)	(0.102)	(0.0811)	(0.162)	(0.0880)	(0.139)
Observations	497	306	497	306	497	306	497	306
R-squared	0.505	0.735	0.404	0.648	0.446	0.595	0.481	0.515
Number of HH		134		134		134		134
Soil & Slope controls	yes	yes	yes	yes	yes	yes	yes	yes
HH FE	yes	yes	yes	yes	yes	yes	yes	yes
Village-Wave FE	yes	yes	yes	yes	yes	yes	yes	yes

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