Contract Farming and Food Security*

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Abstract

Contract farming has been shown to increase participating households' income. It is, however, unclear if contract farming increases other aspects of household welfare. Using data from six regions in Madagascar and controlling for a household's marginal utility of participating in contract farming, we show that participating in contract farming reduces the duration of a household's hungry season by nine days. Further, we find that this effect is even more pronounced for households with a larger number of female children. This is an important result as children, and particularly female children, often bear the largest burden of food insecurity.

Keywords: Contract Farming, Outgrower Schemes, Grower-Processor Contracts, Agricultural Value Chains, Food Security

JEL Classification Codes: L24, O13, O14, Q12

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1 Introduction

Although the benefits of economic specialization have been widely understood since the publication of Adam Smith's (1776, 1976) *Wealth of Nations*, if not earlier, a persistent lack of specialization is perhaps the prime factor that enables economic underdevelopment in most of the world's poorest countries. In those countries, in which economies remain largely agrarian, the transition from subsistence to commercial agriculture – the transition from smallholder farmers producing small quantities of several crops for home consumption to fewer large farms producing large quantities of only one or two crops to sell on the market – has so far proven elusive.

One of the first steps in the transition from subsistence to commercial agriculture is the emergence of an intermediate sector between the agricultural and manufacturing sectors. The institution that perhaps best epitomizes such an agro-industrial sector is contract farming, the economic institution wherein a processing firm contracts the production of commercial crops out to smallholder farmers. In one of the earliest studies of contract farming in economics, Grosh (1994) noted that the institution can resolve several market failures that result from risk and uncertainty, imperfect factor markets, and reluctance to adopt new technology. Since then, contract farming has been studied in many countries and for many crops, and the institution has often been hailed by policy makers as a tool for rural poverty alleviation.

But does participation in agricultural value chains make people better off? Although there is an important literature exploring the effects of participation in contract farming on household income or some variant thereof (Porter and Phillips-Howard, 1997; Singh, 2002; Warning and Key, 2002; Simmons, 2005; Maertens and Swinnen, 2009; Minten et al., 2009; Miyata et al., 2009; Rao and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Michelson, 2013; Narayanan, 2014),[1] we study whether participation in contract farming improves food security. This question is important for two reasons. First, because the hungry season coincides with those weeks and months before households get cash for their crops at harvest, it is not immediately obvious that the households involved in contract farming can or will save the extra income from contract farming (Dupas and Robinson, 2013), and there

[1] A notable exception is Dedehouanou et al. (2013), who look at the impact of contracting on the subjective well-being of farmers in Senegal.

is value in knowing whether income gains translate into other gains.[2] Second, self-control problems are more common among the poor (Banerjee and Mullainathan, 2010), and so it is likewise not immediately obvious that the cash a household receives at harvest will necessarily be spent on necessities like food.

Using a sample of 1,200 households and more than ten contracted crops across six regions of Madagascar, we look at whether participation in contract farming appears to decrease the length of the hungry season – the period during which people eat fewer than three meals per day – experienced by households. Because a household's decision to participate in contract farming is likely to be jointly determined with the duration of the hungry season experienced by the same household, we use the results of a field experiment that elicited the household head's willingness to pay (WTP) to participate in contract farming. This WTP variable is used to identify the causal effect of contract farming on the duration of the hungry season in a selection-on-observables research design (Angrist and Pischke, 2009).

Our results first suggest that participation in contract farming decreases the duration of the hungry season by approximately nine days for the average household in our data. Moreover, our results suggest that participation in contract farming increases the likelihood that a household's hungry season will end at any given time by about 20 percent.

In addition, our findings indicate that the beneficial effects of participation in contract farming are more pronounced (i) the greater the number of children and (ii) the greater the number of female children in a participant household. This is important because children – especially girls – are often the ones who bear the burden of longer hungry seasons given unequal intrahousehold allocations of food, calories, and nutrients (Barrett, 2002). Longer hungry seasons can cause wasting, stunting, and a number of other health problems, and children experience these effects the most during their developmental process.

The rest of this paper is organized as follows. In section 2, we discuss our estimation and identification strategies. Section 3 presents the data and some descriptive statistics. In section 4, we present and discuss our empirical results. Section 5 concludes.

[2]The contracts we study in this paper take place during the main agricultural season in Madagascar. Consequently, it is always the case in the data that people get paid for their contracted crops immediately after the hungry season ends.

2 Empirical Framework

This section first presents the estimation strategy we use in order to study the impact of participation in contract farming on the duration of the hungry season experienced by the households in our data. Then, because the duration of the hungry season experienced by a household is endogenous to its participation in contract farming, we explain the details of the identification strategy we rely on in order to make a causal statement about the impact of participation in contract farming on the duration of the hungry season experienced by the households in our data.

2.1 Estimation Strategy

The core equation we estimate in this paper is

$$y_i = \alpha + \underline{\beta}\underline{x}_i + \gamma D_i + \epsilon_i, \tag{1}$$

where $y_i \geq 0$ is the duration of the hungry season experienced by household i in months, $\underline{x}_i$ is a vector of control variables,[3] D_i is a variable equal to one if household i participates in contract farming and equal to zero otherwise, and ϵ_i is an error term with mean zero.

We are primarily interested in the coefficient γ which, if D were exogenous to y, would be the average treatment effect (ATE) of participating in contract farming on the duration of the hungry season, or

$$\gamma = E(y_i|D_i = 1) - E(y_i|D_i = 0). \tag{2}$$

However, since D is endogenous to y because households participation in contract farming is not assigned at random, we estimate the following version of equation 1:

$$y_i = \alpha + \underline{\beta}\underline{x}_i + \gamma D_i + \underline{\delta}\,\underline{w}_i + \eta_i, \tag{3}$$

where η_i is an error term with mean zero, and $\underline{w}_i$ is a vector of dummy variables that capture our respondents' answers to an experimental question aimed at eliciting WTP to participate in a hypothetical contract farming agreement. Our claim is that this WTP proxies for each respondent's marginal utility of participating in contract farming, which in turn controls

[3] Underlines are used throughout this paper to denote vectors.

for a number of unobservable characteristics which explain selection into contract farming. We thus attempt to identify the ATE of participating in contract farming on the duration of the hungry season using the method of selection on observables, in which a coefficient is identified because the RHS variables (here, $\underline{x}$ and $\underline{w}$) account for selection into a given treatment (here, D).

2.2 Identification Strategy

As discussed, we rely on a selection-on-observables identification strategy in order to estimate the causal impact of participation in contract farming on the duration of the hungry season. This section first explains the experimental setup that we used to elicit WTP for contract farming. It then explains how WTP for contract farming purges the error term, η, of its correlation with the variables on the RHS of equation 3.

2.2.1 Experimental Setup

The contingent valuation experiment used in this paper is the same as the experiment used in Bellemare (2012). Each respondent in our data was asked whether he would participate in a contract farming agreement that would raise his income by 10 percent in exchange for an investment of \$12.50, \$25.00, \$37.50, \$50.00, \$62.50, or \$75.00. The size of investment was determined at random by the throw of a die. For each respondent, the data include a random dollar amount and a "Yes" or "No" answer to whether the respondent would pay an initial investment equal to the random dollar amount in order to participate in a contract farming agreement that would increase his income by 10 percent.

The vector $\underline{w}$ in equation 3 captures respondent answers to the contingent valuation experiment. For example, a respondent who rolls a five on the die throw would be asked whether he'd like to participate in a contract farming agreement that would raise his income by 10 percent, but would require him to pay an initial cost of \$62.50. If he answered "Yes," his $\underline{w}$ vector would be equal to $(1, 1, 1, 1, 1, 0)$. Note that this assumes that if the respondent is willing to pay \$62.50, he is also willing to pay smaller amounts to participate. A respondent who rolls a four on the die throw would be asked whether he'd like to participate in a contract farming agreement that would raise his

income by 10 percent, but would cost \$50.00. If he answered "No," his $\underline{w}$ vector would be equal to $(0, 0, 0, 0, 0, 0, 0)$.

In a second set of estimations we will use a nonparametric measure of WTP to participate in contract farming. The nonparametric WTP variable is equal to the value of the bid if the farmer responded "Yes,"and equal to zero if he said "No."

The identifying assumption made here is that a respondent's response to the contingent valuation question is correlated with his WTP to participate in contract farming, and so the vector $\underline{w}$ serves as a proxy for a respondent's marginal utility from participating in contract farming.

2.2.2 Identification

How does a proxy for a respondent's marginal utility from participating in contract farming help identify the causal impact of participation in contract farming on the duration of the hungry season? Recall that there are three sources of statistical endogeneity:

1. Unobserved heterogeneity,
2. Reverse causality, and
3. Measurement error.

We look at each of these in turn in the remainder of this section.

Unobserved heterogeneity refers to the problem of omitted variables such as a respondent's preferences for risk and ambiguity, his entrepreneurial ability, his technical ability, and his preferences in general, all of which can compromise the identification the ATE if they happen to be correlated with both the duration of the hungry season and any of the variables on the RHS of equation 1. In this application, a great deal of this unobserved heterogeneity can be captured by differences in a respondent's marginal utility for contract farming. Take for example a respondent who is price risk averse (Bellemare et al., 2013). Such a respondent might prefer to participate in contract farming because contract farming arrangements typically insure growers against price risk. Alternatively, a respondent who is very entrepreneurial might have little to no use for contract farming given that she has her own micro-enterprise. Such a respondent might prefer not to participate in contract farming because of the opportunity cost of time associated with being in a

grower-processor contract. In all such cases where a respondent's marginal utility of participating in contract farming varies because of some omitted variable, the variation in WTP measure captures the variation in respondent marginal utility, which should largely obviate concerns about unobserved heterogeneity between respondents.

Reverse causality refers to the statistical endogeneity problem that arises from the fact that the dependent variable might cause the variable of interest. In this case, households that experience a shorter hungry season may be more likely to participate in contract farming. This would compromise the identification of the ATE. This could definitely be a concern in our application given that households that have better access to food may be more willing to enter into contract farming agreements. It should be the case, however, that a respondent who is more willing to enter into a contract farming agreement will have a higher marginal utility of participating in contract farming. Our WTP measure controls for this issue much the same as it did for other changes in preferences, which should obviate concerns about reverse causality.

Finally, measurement error refers to the statistical endogeneity problem that arises from there being measurement error in whether a household participates in contract farming. This is highly unlikely to be a problem in our application given that there is no obvious advantage or disadvantage to misreporting whether one participates in contract farming or not. In addition, the sample was choice-based, i.e., the survey team aimed for a sample in which half the respondents participated in contract farming and half did not, and the survey frame was established with village chiefs, who know who participated in contract farming and who did not. This sampling strategy thus served as a consistency check for whether people truly did participate in contract farming.

In sum, our identification strategy allows us to rule out a number of sources of bias which plague the identification of a causal effect in this context. Because we are dealing with observational data, however, it is impossible to rule out all sources of statistical endogeneity with certainty. As a result, we caution the reader against interpreting our estimate of γ as causal, although it can certainly be interpreted as suggestive that participation in contract farming decreases the duration of the hungry season experienced by grower households.

3 Data and Descriptive Statistics

The data were collected between July and December of 2008 for a study of contract farming that was commissioned by the Economic Development Board of Madagascar (EDBM) on behalf of the World Bank. The data include six regions, with two communes from each region. Three of these regions were chosen because of the relatively high prevalence of contract farming; the other three regions were chosen because EDBM views them as high-priority "growth areas." Within the "growth areas," the two communes with the highest density of contract farming were surveyed. The data for the communes were available in the commune census data. Moser (2008) has a discussion of the methodology used for the 2007 commune census.

Within each of the 12 communes, two lists were generated: one list of all households that participated in contract farming, and a second list of all households that did not participate in contract farming. Then, 50 households were randomly selected from the list of households that participated in contract farming, and 50 were randomly selected from the list of households that did not participate in contract farming. Probability weights are used through out the paper to make the analyzed sample as close to a random sample of the population as possible. Probability weights are based on the sample versus population proportion of contract farmers. The population proportion of contract farmers were collected using a village level questionnaire that surveyed a focus group of village members, usually led by the village chief. The proportion of contract farmers in the sample is found using descriptive statistics from our data.

The survey was conducted in rural ares of Madagascar, thus the vast majority - 96 percent - of households in the sample derive at least some portion of their income from agricultural activities. For each household, data were collected at the household, plot, crop, and contract level.

Table 1 contains a list of all variables used in this analysis along with a thorough description of each. Descriptive statistics for our sample are found in Table 2. We can see that the average duration of the hungry season for the households in our sample is 3.5 months, and approximately half of the surveyed households participate in contract farming. The average household size is 5.6 members and almost half of the individuals in any given household are dependents, that is, they are younger than 15 or older than 65. The vast majority, over 91 percent, of household heads are male. The average household head is 43 years old, has almost six years of education and over 20

years of agricultural experience. More than 20 percent of household heads are members of a Farm Organization, other than contract farming, and the average household head is forbidden from doing agriculture work for 22 days per year for religious reasons.

Average household annual income is approximately US$1153. In Madagascar in 2008, GDP per capita was US$468, while the average per capita income in our sample is US$219, making our sample significantly poorer than the national average. This is unsurprising, given the rural setting. The average household owns US$325 of agricultural equipment and tools, and US$716 in other assets such as a house, TV, radio, and livestock. On average, households have 1.5 hectares of land.

Lastly, Table 2 displays the results of the contingent evaluation experiment. This is the measure of WTP to enter into a hypothetical contract farming agreement. As expected, the portion of farmers who are willing to participate in contract farming declines as the investment required grows.

See Bellemare (2012) for more information about the terms of the grower-processor contracts.

4 Empirical Results

In this section we begin by presenting nonparametric evidence of the relationship between participation in contract farming and duration of the hungry season experienced by households. This nonparametric relationship does not account for the endogeniety of the decision to participate in contract farming. Thus, we then present parametric evidence using a selection-on-observables methodology as explained in Section 2. We then consider if the number of children in the household is associated with different effects of contract farming, conduct robustness checks of our results, and finally discuss the limitations of our approach.

4.1 Nonparametric Evidence

We begin with nonparametric estimations of the relationship between contract farming and the duration of the hungry season in order to establish if a relationship exists. Kaplan-Meier estimates of the survival function are displayed in Figure A. These estimates show that contract farming participants exit the hungry season earlier than non-participants.

Figure 2 displays the Epanechnikov kernel density estimates of the distribution of the number of days spent in the hungry season for households that engage in contract farming and households that do not. We can see that households that participate in contract farming experience a shorter hungry season.

Together these figures suggest that there is a clear relationship, though we cannot yet say if it is causal, between participation in contract farming and the duration of the hungry season experienced by the household.

4.2 Parametric Evidence

We now estimate the relationship between contract farming and duration of the hungry season experienced by the household using the estimation strategy explained in Section 2. We account for the endogenous choice to participate or not participate in contract farming by using a proxy variable for the respondent's marginal utility of participation in contract farming. We control for marginal utility using a respondent's responses to a contingent evaluation question that is correlated with the respondent's WTP to participate in contract farming.

Tables 3 and 4 present the ordinary least squares (OLS), Cox Proportional Hazard, and survival time regression estimates of the duration of the hungry season experienced by the household using all control variables and the sample weights discussed in Section 3. The estimates in Table 3 use the six vectors of WTP measurement to proxy for the respondent's marginal utility of participating in contract farming. The estimates in Table 4 use a nonparametric WTP measurement.

The OLS estimates in column (1) of Table 3 show that households that participate in contract farming experience a hungry season that is 0.28 months, or 8.5 days, shorter than households that do not participate in contract farming. The average household that does not participate in contract farming experiences a 3.8 month hungry season. This implies that contract farming decreases the average length of the hungry season by 7.3 percent. Additionally, we see that female headed households have a longer hungry season, on average. These households experience a 0.73 month, or 22.2 day, increase in the duration of the hungry season. This is an average increase of 19.3 percent in the duration of the hungry season. As expected, households with heads that are younger, more educated, and have more agriculture experience have a shorter hungry season. Finally, households that have higher income and

more assets have a shorter hungry season.

Note first that a negative sign in the OLS estimates indicates that the household experiences a shorter hungry season. However, a positive sign in the Cox and survival time regressions indicates the the household is more likely to exit the hungry season at any given time. The Cox Proportional Hazard and survival time regression estimates in columns (2) and (3) of Table 3 show that participation in contract farming increases the probability that the household's hungry season will end at any given time by 17 and 19 percent, respectively. Female headed households are more likely to remain in the hungry season at any given time, and households with a more educated head and those that are wealthier are more likely to exit the hungry season at any given time.

We turn now to Table 4, which displays the results of the OLS, Cox, and survival time regressions with the same covariates as those that are in Table 3, with one exception. Table 3 uses six dummy variables for the responses to the six possible values of hypothetical payment amounts required to participate in contract farming. Table 4 uses a nonparametric estimate of willingness to pay that combines these six dummy variables as explained in Section 2.2. A nonparametric estimate of WTP is useful here because we are not sure of the functional form of the relationship between these six variables. Estimating WTP nonparametrically gives us more confidence that our results are not driven by functional form assumptions. The reader can see that the results obtained using a nonparametric estimate for WTP are vastly similar in magnitude and significance as those obtained in Table 3.

4.3 Treatment Heterogeneity

We now turn to possible treatment heterogeneity by number and gender of children in the household. Tables 5 and 6 display the results of the OLS, Cox, and survival time regressions with interaction terms between participation in contract farming and the number and gender of children in the household.

In Table 5 we see that, according to the OLS results, as the number children in the household increases, contract farming decreases the duration of the hungry season. For households that participate in contract farming, an additional child in the household is associated with a decrease of 0.19 months, or 5.8 days, in the duration of the hungry season. We do see an increase in the duration of the hungry season for childless households; however, this increase is insignificant.

The Cox and survival time regression estimates show that for an additional child in the household, contract farming increases the probability of exiting the hungry season by 6 and 7 percent, respectively. All additional control variables are similar in magnitude and significance as those in Tables 3 and 4.

Table 6 shows how contract farming affects households with different numbers of male and female children. We see in Table 6 that the results in Table 5 are mainly driven by the effects on households with female children. That is, contract farming reduces the duration of the hungry season by 0.22 months for each additional female child, while the relationship with the number of male children is insignificant. Further, contract farming increases the likelihood of exiting the hungry season by between 12 and 14 percent for each additional female child. The relationship between the likelihood of exiting the hungry season and the number of male children is insignificant. Again, we see that the significance levels and magnitude of the coefficients on the other control variables are largely similar to those found in Tables 3, 4, and 5.

4.4 Robustness Checks

In the proceeding subsections we have seen that the results are robust to three regression estimators, two specifications of our WTP variable, and two interaction terms with our variable of interest. In this subsection, we further scrutinize our findings to determine if the results are robust to two additional regression estimators. We use a quantile regression and robust regression (Rousseeuw and Leroy 1987) techniques. These results are found in Table 7.

Column (1) of Table 7 shows that for households with the median level of food insecurity, contract farming decreases the duration of the hungry season by 0.306 months, or nine days. Similarly, the robust estimator indicates that contract farming reduces the duration for participating households by about 0.255 months, or eight days, on average. These results corroborate the results of each specification previously discussed.

4.5 Limitations

It is important to discuss the limitations of our findings. First, while we have proxied for a very important source of unobserved heterogeneity by using the responses to a contingent evaluation question, it is possible that

this proxy variable is imperfect. This is particularly true, given the nature of the construction of the WTP variable. Nevertheless, these results bring us closer to exogenizing the choice to participate in contract farming, and thus provide valuable information. Second, a more objective measures of food insecurity would be useful in such an analysis. We have used self-reported data on the number of days spent eating fewer than three meals per day. More objective measures such as BMI for adults, and weight-for-height for children would be beneficial for confirming our findings.

5 Concluding Remarks

The results clearly and robustly show that engaging in contract farming reduces the duration of the hungry season by approximately nine days for the average participating household. Although past research has shown that contract farming increases the income of participating farmers (Porter and Phillips-Howard, 1997; Singh, 2002; Warning and Key, 2002; Simmons, 2005; Maertens and Swinnen, 2009; Minten et al., 2009; Miyata et al., 2009; Rao and Qaim, 2011; Barrett et al., 2012; Bellemare, 2012; Michel- son, 2013; Narayanan, 2014), these studies do not address if contract farming improves food security. There are channels through which the link between increased income and increased food security could fail. We find that in fact contract farming does translate into increased food security for participating households.

Further, household with more children benefit more from contract farming, and in particular those households with female children benefit the most. This is an important result as children, and particularly female children, bear the largest burden of food insecurity. These burdens include stunting, wasting, listlessness, and cognitive impairment.

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A Tables and Figures

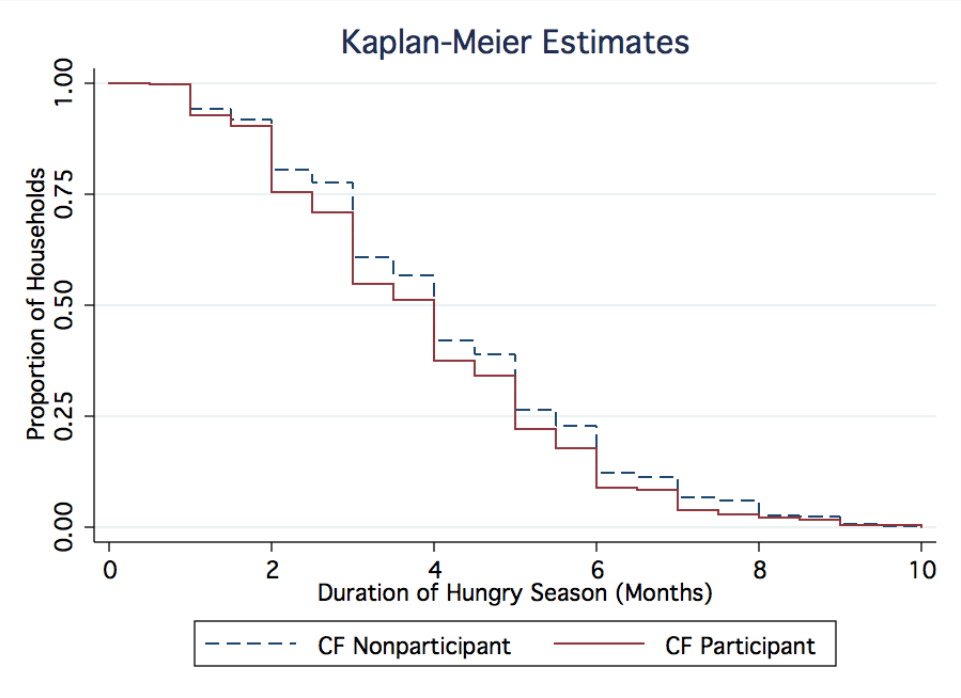

Figure 1: Nonparametric Survival Plot for the Duration of the Hungry Season by Participation Status.

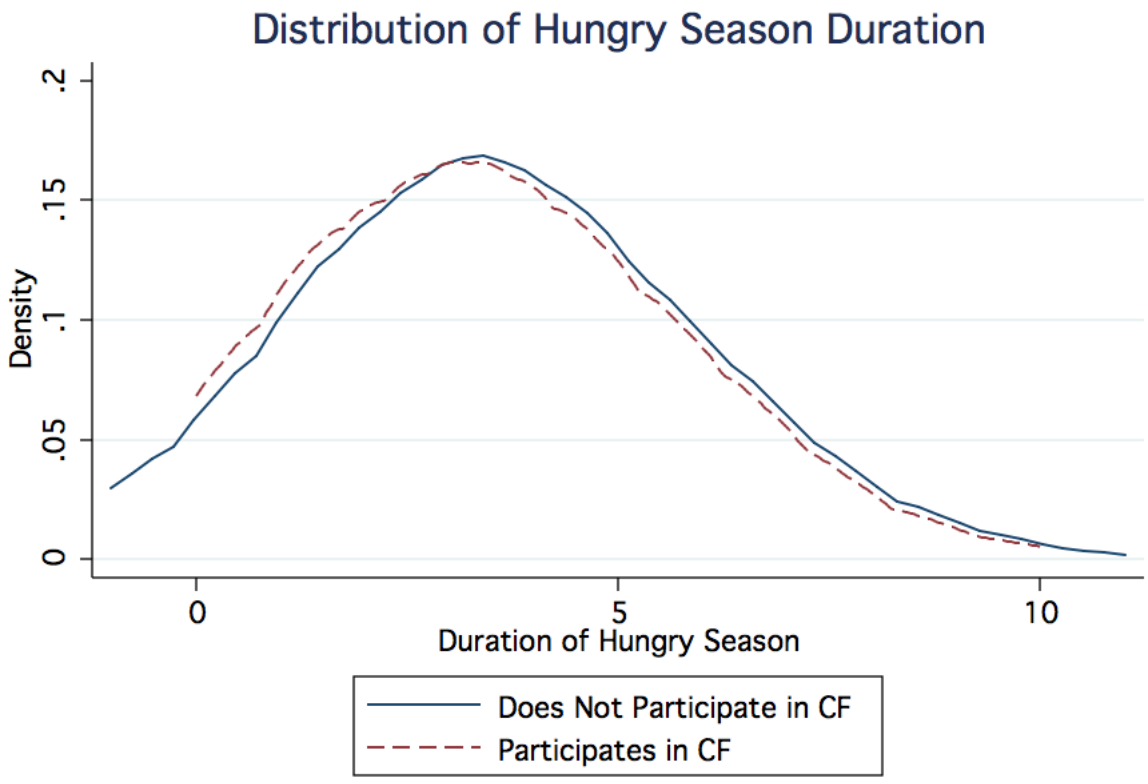

Figure 2: Epanechnikov Kernel Density Estimate of the Distribution of the Duration of the Hungry Season by Participation Status. Bandwidth is 1.00.

Table 1: Variable Descriptions

Variable	Description
Duration of the Hungry Season	Number of months the last hungry season lasted. For households who experience two hungry seasons, this measures the total duration.
Contract Farming Participant	Equal to 1 if the household participates in contract farming and equal to 0 otherwise.
Household Size	Number of individuals in the household.
Dependency Ratio	Number of individuals younger than 15 or older than 65 as a proportion of the total number of individuals in the household.
Household Head Single	Equal to 1 if the household head is single and equal to 0 otherwise.
Household Head Female	Equal to 1 if the household head is female and equal to 0 otherwise.
Household Head Migrant	Equal to 1 if the household head migrated to the village from elsewhere and equal to 0 otherwise.
Household Head Age	Age of the household head in years.
Household Head Education	Education of the household head in years.
Household Head Agricultural Experience	Agricultural experience of the household head in years.
Household Head Member of a Farm Organization	Equal to 1 if the household head is a member of a farmer organization and equal to 0 otherwise.
Number of Taboo Days	Number days per year for which agricultural work is forbidden by religion
Household Income	Household income from animal sales, wages, nonfarm businesses, and agriculture in 100,000 Ariary.
Household Working Capital	Household working capital (i.e., agricultural equipment and tools) in 100,000 Ariary.
Household Assets	Household assets (i.e., house, TV, radio, bicycle, bank account, livestock, jewelry, and businesses) in 100,000 Ariary.
Household Landholdings	Landholdings of the household measured in ares (1 are = 0.01 hectares, or 100 square meters).
Yes to $12.50 Investment Dummy	Equal to 1 if the household head received $12.50 or higher as his bid and said “Yes” to the hypothetical.
Yes to $25.00 Investment Dummy	Equal to 1 if the household head received $25.00 or higher as his bid and said “Yes” to the hypothetical.
Yes to $37.50 Investment Dummy	Equal to 1 if the household head received $37.50 or higher as his bid and said “Yes” to the hypothetical.
Yes to $50.00 Investment Dummy	Equal to 1 if the household head received $50.00 or higher as his bid and said “Yes” to the hypothetical.
Yes to $62.50 Investment Dummy	Equal to 1 if the household head received $62.50 or higher as his bid and said “Yes” to the hypothetical.
Yes to $75.00 Investment Dummy	Equal to 1 if the household head received $75.00 as his bid and said “Yes” to the hypothetical.
Nonparametric Willingness to Pay	Willingness to pay estimate obtained by multiplying each respondents random bid by his answer to the hypothetical question.

Table 2: Descriptive Statistics

Variable	Mean (St. Err.)
Duration of Hungry Season	3.507***
	(0.076)
Contract Farming Participant	0.498***
	(0.016)
Household Size	5.571***
	(0.075)
Dependency Ratio	0.449***
	(0.008)
Household Head Single	0.124***
	(0.011)
Household Head Female	0.088***
	(0.010)
Household Head Migrant	0.125***
	(0.011)
Household Head Age	43.274***
	(0.431)
Household Head Education	5.682***
	(0.106)
Household Head Agricultural Experience	20.621***
	(0.433)
Household Head Member of a Farm Organization	0.222***
	(0.014)
Number of Days When Agricultural Work is Taboo	22.204***
	(1.105)
Household Income	19.531***
	(1.506)
Household Working Capital	4.440***
	(0.522)
Household Assets	13.965***
	(0.876)
Land Holdings	145.569***
	(10.138)
Yes to $12.50 or Higher Investment	0.736***
	(0.015)
Yes to $25.00 or Higher Investment	0.604***
	(0.016)
Yes to $37.50 or Higher Investment	0.425***
	(0.016)
Yes to $50.00 or Higher Investment	0.268***
	(0.014)
Yes to $62.50 or Higher Investment	0.135***
	(0.011)
Yes to $75.00 Investment	0.066***
	(0.008)
Nonparametric Willingness to Pay	27.908***
	(0.766)
Observations	1,178

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

Table 3: Estimation Results for the OLS, Cox Proportional Hazards, and Survival Time Regression Specifications Using Responses to the Contingent Valuation Experiment as Controls

Variable	(1) OLS	(2) Cox	(3) Survival
Contract Farming Participant	-0.277*	0.166***	0.188***
	(0.145)	(0.063)	(0.071)
Household Size	0.052	-0.013	-0.015
	(0.036)	(0.015)	(0.017)
Dependency Ratio	0.517	-0.226	-0.247
	(0.366)	(0.158)	(0.181)
Household Head Single	-0.126	0.042	0.068
	(0.343)	(0.147)	(0.167)
Household Head Female	0.732*	-0.323*	-0.390*
	(0.402)	(0.175)	(0.202)
Household Head Migrant	0.064	0.014	0.009
	(0.219)	(0.101)	(0.115)
Household Head Age	0.021**	-0.003	-0.003
	(0.009)	(0.004)	(0.005)
Household Head Education	-0.068***	0.022**	0.026**
	(0.022)	(0.010)	(0.011)
Household Head Agricultural Experience	-0.029***	0.005	0.004
	(0.010)	(0.004)	(0.005)
Household Head Member of a Farm Organization	0.091	-0.095	-0.125
	(0.183)	(0.088)	(0.100)
Number of Days When Agricultural Work is Taboo	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.006***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.002)
Land Holdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Yes to $12.50 or Higher Investment	0.218	-0.033	-0.027
	(0.217)	(0.095)	(0.107)
Yes to $25.00 or Higher Investment	-0.614***	0.140	0.154
	(0.231)	(0.099)	(0.112)
Yes to $37.50 or Higher Investment	0.008	0.020	0.020
	(0.232)	(0.103)	(0.118)
Yes to $50.00 or Higher Investment	0.183	-0.144	-0.164
	(0.250)	(0.122)	(0.140)
Yes to $62.50 or Higher Investment	0.063	0.021	0.022
	(0.328)	(0.153)	(0.177)
Yes to $75.00 Investment	0.293	-0.229	-0.240
	(0.415)	(0.203)	(0.228)
Constant	3.793***		-4.152***
	(0.456)		(0.256)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
Joint Significance of Investment Dummies (p-value)	0.075	0.338	0.364
R-squared	0.206		

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

Table 4: Estimation Results for the OLS, Cox Proportional Hazards, and Survival Time Regression Specifications Using Nonparametric Willingness to Pay as a Control

Variable	(1) OLS	(2) Cox	(3) Survival
Contract Farming Participant	-0.279*	0.159**	0.180**
	(0.144)	(0.062)	(0.070)
Household Size	0.051	-0.010	-0.012
	(0.036)	(0.015)	(0.017)
Dependency Ratio	0.564	-0.263*	-0.296
	(0.365)	(0.159)	(0.183)
Household Head Single	-0.090	0.045	0.075
	(0.338)	(0.147)	(0.167)
Household Head Female	0.727*	-0.344*	-0.419**
	(0.398)	(0.176)	(0.205)
Household Head Migrant	0.036	0.028	0.023
	(0.217)	(0.102)	(0.117)
Household Head Age	0.023**	-0.005	-0.005
	(0.009)	(0.004)	(0.005)
Household Head Education	-0.068***	0.021**	0.025**
	(0.022)	(0.010)	(0.012)
Household Head Agricultural Experience	-0.032***	0.006	0.006
	(0.010)	(0.004)	(0.005)
Household Head Member of a Farm Organization	0.109	-0.105	-0.140
	(0.184)	(0.087)	(0.099)
Number of Days When Agricultural Work is Taboo	-0.003	0.000	0.000
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.006***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.002)
Land Holdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Nonparametric Willingness to Pay	-0.002	-0.001	-0.001
	(0.003)	(0.001)	(0.002)
Constant	3.598***		-3.977***
	(0.443)		(0.251)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.197		

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

Table 5: Estimation Results for the OLS, Cox Proportional Hazards, and Survival Time Regression Specifications Exploring Treatment Heterogeneity I

Variable	(1) OLS	(2) Cox	(3) Survival
Contract Farming Participant	0.210	0.009	0.004
	(0.253)	(0.109)	(0.125)
Contract Farming Participant*Number of Children	-0.191**	0.060*	0.070*
	(0.082)	(0.034)	(0.039)
Number of Children	0.172	-0.053	-0.060
	(0.121)	(0.050)	(0.057)
Household Size	0.007	0.002	0.002
	(0.059)	(0.028)	(0.032)
Dependency Ratio	0.255	-0.168	-0.187
	(0.583)	(0.231)	(0.259)
Household Head Single	-0.164	0.056	0.085
	(0.349)	(0.150)	(0.171)
Household Head Female	0.765*	-0.330*	-0.399*
	(0.406)	(0.176)	(0.204)
Household Head Migrant	0.066	0.006	-0.002
	(0.219)	(0.102)	(0.115)
Household Head Age	0.024**	-0.004	-0.004
	(0.010)	(0.004)	(0.005)
Household Head Education	-0.068***	0.022**	0.026**
	(0.022)	(0.010)	(0.012)
Household Head Agricultural Experience	-0.029***	0.004	0.003
	(0.010)	(0.004)	(0.005)
Household Head Member of a Farm Organization	0.087	-0.088	-0.115
	(0.180)	(0.086)	(0.097)
Number of Days When Agricultural Work is Taboo	-0.003	0.000	0.001
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.000	0.000
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.005***	0.007***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.001)
Land Holdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Yes to $12.50 or Higher Investment	0.197	-0.028	-0.022
	(0.217)	(0.095)	(0.107)
Yes to $25.00 or Higher Investment	-0.612***	0.135	0.148
	(0.232)	(0.099)	(0.112)
Yes to $37.50 or Higher Investment	0.043	0.017	0.019
	(0.232)	(0.103)	(0.119)
Yes to $50.00 or Higher Investment	0.177	-0.129	-0.144
	(0.244)	(0.119)	(0.136)
Yes to $62.50 or Higher Investment	0.054	0.016	0.014
	(0.318)	(0.150)	(0.174)
Yes to $75.00 Investment	0.336	-0.256	-0.272
	(0.409)	(0.203)	(0.228)
Constant	3.592***		-4.078***
	(0.487)		(0.271)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.213		

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

Table 6: Estimation Results for the OLS, Cox Proportional Hazards, and Survival Time Regression Specifications Exploring Treatment Heterogeneity II

Variable	(1) OLS	(2) Cox	(3) Survival
Contract Farming Participant	0.206	-0.005	-0.013
	(0.254)	(0.109)	(0.125)
Contract Farming Participant*Female Children	-0.215*	0.118**	0.137**
	(0.120)	(0.054)	(0.061)
Contract Farming Participant*Male Children	-0.163	0.015	0.018
	(0.120)	(0.048)	(0.054)
Female Children	0.214	-0.067	-0.076
	(0.133)	(0.056)	(0.063)
Male Children	0.129	-0.026	-0.028
	(0.141)	(0.057)	(0.065)
Household Size	0.007	-0.002	-0.003
	(0.059)	(0.028)	(0.032)
Dependency Ratio	0.258	-0.196	-0.223
	(0.584)	(0.231)	(0.258)
Household Head Single	-0.167	0.058	0.088
	(0.348)	(0.148)	(0.169)
Household Head Female	0.766*	-0.336*	-0.406**
	(0.406)	(0.175)	(0.202)
Household Head Migrant	0.061	-0.001	-0.009
	(0.221)	(0.102)	(0.116)
Household Head Age	0.024**	-0.004	-0.004
	(0.010)	(0.004)	(0.005)
Household Head Education	-0.067***	0.023**	0.027**
	(0.023)	(0.010)	(0.012)
Household Head Agricultural Experience	-0.029***	0.004	0.003
	(0.010)	(0.004)	(0.005)
Household Head Member of a Farm Organization	0.084	-0.096	-0.123
	(0.179)	(0.086)	(0.098)
Number of Days When Agricultural Work is Taboo	-0.003	0.000	0.001
	(0.002)	(0.001)	(0.001)
Household Income	-0.004**	0.001	0.001
	(0.002)	(0.001)	(0.002)
Household Working Capital	0.002	0.005***	0.006***
	(0.003)	(0.002)	(0.002)
Household Assets	-0.013***	0.004***	0.005***
	(0.003)	(0.001)	(0.001)
Land Holdings	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Yes to $12.50 or Higher Investment	0.191	-0.025	-0.017
	(0.216)	(0.095)	(0.106)
Yes to $25.00 or Higher Investment	-0.611***	0.129	0.140
	(0.232)	(0.098)	(0.111)
Yes to $37.50 or Higher Investment	0.053	0.018	0.020
	(0.232)	(0.103)	(0.118)
Yes to $50.00 or Higher Investment	0.174	-0.137	-0.155
	(0.245)	(0.119)	(0.136)
Yes to $62.50 or Higher Investment	0.055	0.012	0.009
	(0.318)	(0.152)	(0.175)
Yes to $75.00 Investment	0.331	-0.247	-0.262
	(0.409)	(0.205)	(0.230)
Constant	3.586***		-4.069***
	(0.486)		(0.271)
Observations	1,178	1,045	1,045
District Fixed Effects	Yes	Yes	Yes
R-squared	0.213		

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

Table 7: Robustness Checks on the Core Results

Variables	(1) Quantile	(2) Robust
Contract Farming Participant	-0.306**	-0.255**
	(0.135)	(0.121)
Household Size	0.023	0.040
	(0.032)	(0.029)
Dependency Ratio	0.331	0.364
	(0.323)	(0.291)
Household Head Single	0.275	0.114
	(0.315)	(0.285)
Household Head Female	0.095	0.290
	(0.359)	(0.326)
Household Head Migrant	-0.034	0.070
	(0.207)	(0.187)
Household Head Age	0.022**	0.024***
	(0.010)	(0.009)
Household Head Education	-0.040*	-0.049**
	(0.021)	(0.019)
Household Head Agricultural Experience	-0.022**	-0.026***
	(0.010)	(0.009)
Household Head Member of a Farm Organization	-0.092	-0.037
	(0.165)	(0.148)
Number of Days When Agricultural Work is Taboo	-0.002	-0.003
	(0.002)	(0.002)
Household Income	-0.008***	-0.006***
	(0.002)	(0.002)
Household Working Capital	0.002	0.002
	(0.003)	(0.003)
Household Assets	-0.011***	-0.012***
	(0.003)	(0.002)
Land Holdings	0.000	-0.000
	(0.000)	(0.000)
Yes to $12.50 or Higher Investment	0.217	0.191
	(0.225)	(0.202)
Yes to $25.00 or Higher Investment	-0.706***	-0.610***
	(0.242)	(0.217)
Yes to $37.50 or Higher Investment	0.241	0.151
	(0.229)	(0.206)
Yes to $50.00 or Higher Investment	-0.232	-0.087
	(0.238)	(0.214)
Yes to $62.50 or Higher Investment	0.321	0.171
	(0.309)	(0.277)
Yes to $75.00 Investment	-0.126	-0.006
	(0.349)	(0.313)
Constant	3.999***	3.751***
	(0.430)	(0.388)
Observations	1,178	1,178
District Fixed Effects	Yes	Yes
R-squared		0.200

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