Contract Farming and Rural Transformation: Evidence from a Field Experiment in Benin*

Aminou Arouna[a], Jeffrey D. Michler[b], and Jourdain C. Lokossou[c]

[a] *Africa Rice Center (AfricaRice), Bouake, Cote d'Ivoire*
[b] *Department of Agricultural and Resource Economics, University of Arizona, Tucson, USA*
[c] *International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Bamako, Mali*

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Abstract

In recent decades contract farming has emerged as a popular mechanism to encourage vertical coordination in developing country agriculture. The goal of such coordination is to better integrate smallholder farmers into the modern agricultural food system, fostering rural transformation. We use panel data from a randomized control trial to quantify the impact of different contract attributes on rural transformation and welfare of smallholder rice farmers in Benin. We vary the terms of contract, with some farmers being offered a contract that only guarantees a price, while other contracts add extension training or input loans. While all three types of contracts had positive and significant effects, we find that contracts which only included an agreement on price had nearly as large of an impact as did contracts with additional attributes. This suggests that once price uncertainty is resolved, farmers are able to address other constraints on their own.

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1. Introduction

Structural transformation is a fundamental challenge in developing countries and key to overcoming food insecurity and poverty, particularly in Sub-Saharan Africa. Value chain development, especially in staple crops, is one potential method for fostering rural transformation (Poulton et al. 2014; World Bank, 2016). In countries where smallholder farmers are a large percentage of the population, the transition from subsistence to commercial agriculture, has proven elusive. For rural transformation to occur, smallholder farmers must increase their area planted, increase their productivity level, and sell more of their crop into the market, thereby increasing their income and profit from production. However, smallholder farmers generally lack access to credit (Berg, 2013; Stephens and Barrett, 2011), limiting their ability to increase input use as well as profit from their output (McArthur and McCord, 2017). In addition, evidence shows that smallholder farmers frequently produce well below the technical efficiency frontier, limiting the marginal returns to inputs (Hanna et al, 2014; Sherlund et al., 2002). Finally, limited access or price uncertainty in the output market can reduce the incentives to invest in improved inputs (Kim et al., 1992) or result in reduced revenue from production (Saha, 1994). These constraints affect input demand, as well as productivity, sales, and income, resulting in a perpetuation of the agrarian status quo.

One approach towards making the transition from subsistence to commercial agriculture is to increase vertical coordination between farmers and processors. In recent years, contract farming has emerged as a popular mechanism to encourage such vertical coordination (Barrett et al., 2012; Reardon et al., 2009; Swinnen and Maertens, 2007). Farm contracts can shift risk and the need for initial capital from smallholders to medium and large processors better able to manage these issues. In return, firms secure a stream of quality inputs for processing. While many see contract farming as a way to spur rural transformation and growth in local economies the view is far from universal.[1] As Bellemare and Bloem (2018) and Ton et al. (2018) recently point out, one reason for the lack of consensus on the impacts of contract farming in developing countries is that, up till now, studies have relied exclusively on observational data and many have been limited to cross-sectional data.

In this paper, we present results from the first field experiment on contract farming in a developing country context.[2] We work with a rice processing company in Benin to vary the terms of production

[1] Studies have found positive impacts of contract farming on income (Bellemare, 2012; Bellemare and Lim, 2018; Gatto et al., 2017; Miyata et al., 2009; Soullier and Moustier, 2018), on food security (Bellemare and Lim, 2018; Bellemare and Novak, 2017; Mishra et al., 2018; Soullier and Moustier, 2018), on assets (Michelson, 2013), on subjective wellbeing (Vath et al., Forthcoming), and on increased input use (Deb and Suri, 2013). The literature has documented problems affecting contract farming performance, which include biased terms of trade (Singh, 2002), below market prices (Michelson et al., 2012), higher production costs (Ragasa et al., 2018), lack of compensation for crop failure (Guo et al., 2005), and high opportunity costs (Bellemare, 2018).

[2] Ashraf et al. (2009) and Buchardi et al. (2019) are potential candidates for the first field experiment on contract farming. However, Ashraf et al. randomize "services offered" by an NGO that helps farmers export crops, not with the processing and export firm itself. While these services resemble farming contracts, Ashraf et al. never refer to

contracts offered to smallholder farmers. To help establish causal identification, we first conducted a baseline survey on household farm production. We then conduct a randomized control trial (RCT) in which we offer one of three production contracts to a randomly selected subset of farm households. Our experimental design allows us to compare differences in outcomes between farmers offered contracts and those in the control, differences within farmers, and differences between contract attributes.

We begin by developing a model of stochastic farm production, in which farmers face uncertainty regarding the price of their product, can produce below the technical efficiency frontier, and may also face binding capital constraints. Our theoretical model demonstrates that any one of these risk/constraints results in suboptimal levels of input demand, and by extension input productivity, output supply, and profitability. To address these issues, we return to the early work of Mighell and Jones (1963) to develop three types of production contracts. The first is a market-specifying contract in which our implementing partner offers farmers a guaranteed price for their rice production.[3] The second is a production-management contract in which the processor sends extension agents three to five times throughout the growing season to provide technical training and backstopping. The third is a resource-providing contract in which the processor provides input loans for seed and fertilizer and deducts the cost at harvest. Because of our implementing partner's finite resources and the need to ensure sufficient power, in our RCT we randomly offer 1) a contract that provides a price guarantee, 2) a contract that combines extension training with the price guarantee, and 3) a contract that provides input loans in addition to the extension training and price guarantee.

Our results demonstrate that contract farming has positive and significant impacts on a number of different measures of rural transformation, including area planted to rice, yield, the share of output sold in the market, and income earned from rice production. We also find that impacts on these four outcome variables are heterogeneous depending on the terms of the contract. The contract that only provides a price guarantee had positive and significant results on productivity, market participation, and income, but not on area planted to rice. The contracts that added extension training and input loans significantly increased all four measured outcomes. Besides the positive and significant impact of contract farming on rural transformation, a key finding of our study is that contracts that offer only a price guarantee produced large effects. The provision of a price guarantee frequently resulted in outcomes statistically indistinguishable in their magnitude from more complex (and costlier) contracts that provide extension training and/or input

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the treatments as contracts. Burchardi et al. randomize the terms of sharecropping contracts to investigate moral hazard.

[3] This contract, as with all the contracts, also specifies a given quantity which the processor is willing to purchase and defines the requisite level of quality. The quantity level was set high enough to ensure that farmers could produce has much rice as they wanted without exceeding their limit. The quality constraint was focused on the amount of particulate matter in the rice (stones, leaves, dirt) mainly to ensure farmers did not simply fill their bags with debris instead of rice.

loans. This suggests that once price uncertainty is resolved, farmers can, on their own, address issues of technical efficiency and capital constraints.

Our study contributes to the existing literature in several ways. First and foremost, it provides the first experimental evidence on the impact of contract farming in the developing world. Second, it assesses the impact of different contract attributes on rural transformation. Although empirical studies in developing countries provide diverse analysis of the participation and income effects of contract farming (Bellemare and Bloem, 2018; Ton et al., 2018), the existing literature does not address the impact of different contract attributes on production and income. We show that while contract farming has a positive impact on several measures of smallholder production and income, the terms of the contracts matter. Our study provides a more detailed picture of which attributes of a typical farming contract have significant impacts, and which attributes do not. These insights should prove useful to policymakers interested in fostering or expanding contract farming for rural transformation. Finally, we focus our experiment on contract farming of a staple crop. The majority of the literature on contracting farming in developing countries focuses on high-value and specialty crops (Swinnen et al., 2010; Mishra et al., 2018). Unlike specialty crops, the margins, and therefore the incentives, for staple crop cultivation are small, even given the generous terms of the contracts offered to farmers by our implementing partner. This suggests that our results should not only be generalizable to contract farming for other staple crops but may be a lower bound on the impacts that contract farming has on higher margin specialty crops.

2. Theoretical framework

In this section we develop a model of agricultural production to help clarify the issues facing rural farmers and how various contract attributes address these issues. We start with a stochastic specification of the production technology, as in Just and Pope (1978). To this we add a measure of technical inefficiency, as in Khumbakar (2001). We also allow for output price uncertainty and introduce a capital constraint, which limits the farmer's ability to purchase inputs.

Assume the production technology can be represented as:

$$y = f(x) + g(x)\epsilon \tag{1}$$

where y is output, x is a vector of inputs, and $f(x)$ is mean output. Perturbations to production are captured by $g(x)\epsilon$, where $\epsilon = v - \tau$. τ is a measure of technical inefficiency and $v \sim (0,1)$ captures random shocks to production. We model price uncertainty as in Zellner et al. (1966), such that:

$$p^e = pe^u \tag{2}$$

where p^e is expected price, which is a function of observed price, p, and a random disturbance term, $e^u \sim (1, \sigma)$. Farmers face a capital constraint which can limit their ability to purchase the optimal level of inputs:

$$r \cdot x \leq k \tag{3}$$

where r is a vector of input prices and k is the amount of capital available to the farmer.

We assume farmers maximize expected utility of anticipated profits subject to their capital limitation. We can write the farmer's problem as

$$\max_x E[U(\pi^e)] = p^e y - r \cdot x + \lambda(k - r \cdot x) \tag{4}$$

$$= pf(x) - r \cdot x + pf(x)\sigma\left(\frac{e^u - 1}{\sigma}\right) + pg(x)\left\{\sqrt{1+\sigma^2}\left(\frac{e^u v}{\sqrt{1+\sigma^2}}\right) - \tau\right\} + \lambda(k - r \cdot x) \tag{5}$$

$$= \mu_\pi + pf(x)\sigma z_1 + pg(x)\left\{\sqrt{1+\sigma^2} z_2 - \tau\right\} + \lambda(k - r \cdot x) \tag{6}$$

Here $\mu_\pi = pf(x) - r \cdot x$, $z_1 = \left(\frac{e^u - 1}{\sigma}\right)$ and $z_2 = \left(\frac{e^u v}{\sqrt{1+\sigma^2}}\right)$ are standardized random variables, and λ is the Lagrange multiplier on the capital constraint. This yields the first order condition:

$$E\left[U'(\pi^e)\left(pf_j(x) - r_j + pf_j(x)\sigma z_1 + pg_j(x)\sqrt{1+\sigma^2} z_2 - pg_j(x)\tau - \lambda r_j\right)\right] = 0 \tag{7}$$

By passing through the expectation operator, we can rewrite the above equation as:

$$pf_j(x)\left(1 + \sigma\frac{E[U'(\pi^e)z_1]}{E[U'(\pi^e)]}\right) = r_j(1+\lambda) - \ pg_j(x)\sqrt{1+\sigma^2}\left(\frac{E[U'(\pi^e)z_2]}{E[U'(\pi^e)]}\right) + pg_j(x)\tau \tag{8}$$

Further simplifying, we get

$$pf_j(x)(1 + \sigma\psi) = r_j(1+\lambda) - \ pg_j(x)\sqrt{1+\sigma^2}\theta + pg_j(x)\tau \tag{9}$$

where $\psi = \frac{E[U'(\pi^e)z_1]}{E[U'(\pi^e)]}$ and $\theta = \frac{E[U'(\pi^e)z_2]}{E[U'(\pi^e)]}$ are risk preference functions. If we assume farmers are risk averse, then $\psi < 0$ and $\theta < 0$. An increase in v, u, z_1, or z_2 increases π^e, which in turn reduces $U'(\pi^e)$ since utility is concave (i.e., $U''(\pi^e) < 0$).

We can rewrite the first order condition as:

$$pf_j(x) = r_j\varphi_j \qquad (10)$$

where

$$\varphi_j = \frac{(1+\lambda) - pg_j(x)\sqrt{1+\sigma^2}\theta + pg_j(x)\tau}{1+\sigma\psi} \qquad (11)$$

For risk averse farmers, $\varphi_j \neq 1$, which means that farmers do not equate the expected marginal value of an input to its price. The size of the distortion to optimal input use depends on the size of σ, τ, and λ. If Farmer A faces uncertainty in output price ($\sigma^2 > 0$) compared to an identical Farmer B facing no uncertainty ($\sigma^2 = 0$), Farmer A will have a larger φ_j than Farmer B, resulting in Farmer A using less of input j relative to Farmer B. Similarly, it can be shown that technical inefficiency ($\tau \neq 0$) as well as a binding capital constraint ($\lambda \neq 0$), increases the size of φ_j, resulting in underutilization of input j relative to identical farmers who are not capital constrained ($\lambda = 0$) and/or are technically efficient ($\tau = 0$). Consequently, anything that depends on input demand functions, such as input productivity, output supply, and profitability, will also be affected by σ, τ, and λ.

Contract farming is a mechanism that can reduce or eliminate price uncertainty (σ), technical inefficiency (τ), and capital constraints (λ). In their seminar work, Mighell and Jones (1963) classify farming contracts into three categories: 1) market-specifying contracts, which describe the terms of the sales transaction with regard to price, quantity, timing, and product attributes; 2) production-management contracts, which specify the way the commodity is to be grown, such as the planting density, use of pesticides, and timing of harvest; and 3) resource-providing contracts, in which the buyer provides inputs, often on credit. Each type of contract addresses a different source of risk or constraints. Since reduction in any of the three risks/constraints will impact input demand functions, and by extension input productivity, output supply, and revenue, any of the three types of contracts can have a positive effect on rural transformation. It is therefore an empirical, and context dependent, question regarding which contract attributes will be most effective in reducing risks and easing constraints.

3. Study design and data collection

3.1. Data and sampling

The data for this study come from two rounds of a household-level experimental panel survey. The baseline survey was conducted in July 2016, prior to the experiment, followed by an endline survey conducted in January 2017. The baseline survey collected information on the 2015-16 rice growing season, along with sociodemographic characteristics.[4] The endline survey collected information on the 2016-17 growing season, as well as any changes to household characteristics.

To select the study area and representative households in our sample, we used a multi-level stratified sampling approach. First, we selected four districts in the central part of Benin. These districts were selected due to their importance in rice production in Benin and because they were areas in which our implementing partner had previously operated. Second, we obtained a list of rice farmers in these districts from the National Office of Agricultural Statistics. We contacted these farmers to determine their willingness to participate in an experiment on contract farming. Third, among those farmers who consented to participate, we requested that they form farmer group of 8 farmers each, which was our level of randomization.[5] In total, we had 953 farmers organized into 107 farmer groups.[6]

In the baseline survey we asked farmers about their previous experience with contract farming. Contract farming was relatively well known among participant farmers, with 87 percent aware of the existence of contract farming and 71 percent having engaged in at least one contract for crop production (Table 1). The vast majority of these contracts, 91 percent, were oral agreements. Twenty-eight percent of farmer had participated in contracts that provided input loans. Farmers who had participated in contracts that stipulated price or quantity 33 and 40 percent respectively. The most common type of contract stipulated quality, 83 percent. It is important to note that most farming contracts were for cotton, which represents a cash crop in the surveyed area.

[4] Due to delays in the release of some funds, the survey team was unable to conduct the baseline immediately after harvest (January 2016).

[5] Randomization was at the group level to avoid potential spillover effects from neighboring farmers offered different contract terms. It was also necessary as a way to simplify the logistics of delivering inputs and collecting output at the end of the season.

[6] While farmers were instructed to form groups of 8, in reality group size varied. Mean group size ended up being 8.9 farmers.

3.2. Experimental design

The experiment was implemented in collaboration with *Entreprises de Services et Organisations de Producteurs de Bante* (ESOP), a private rice processing and marketing unit that has experience in purchasing rice through farming contracts.

Subsequent to the household-level baseline survey, farmer groups were randomly assigned to either treatment or control. Among those assigned to treatment, groups were further randomly assigned to receive one of three types of contracts. Random assignment was conducted at a meeting at the end of July 2016 in which the objectives of the experiment were explained. At the end of the meeting, each farmer allocated to the treatment group signed a written contract with the rice milling unit of ESOP.[7] For all contracts, the sale price was fixed at US$0.27 per kg.[8] The market price at harvest typically ranges from US$0.20 to US$0.33 per kg, depending on the buyer (collectors, traders, or consumers) and the place of sale (farm gate, village, or market).

The first treatment (T1) provided a contract to farmers which specified the price and quantity of rice that ESOP was willing to buy, conditional that the rice met a minimum threshold for the percentage of impurities present (pebbles and other debris). In addition to setting price, quantity, and quality, the contract specified the variety of rice that the farmer must grow (IR841), the date and location where the rice would be collected, and the size of bags the rice must be delivered in (80-100kg bags). The contract also defined how breach of contract was to be resolved. Contracts were signed by an ESOP representative with individual farmers in the presence of fellow group members and were witnessed as well.

The second treatment (T2) provided a contract that included all the attributes of T1 and added the provision of extension training. The contract stipulated that throughout the season, farmers would receive between three and five technical training and backstopping visits from ESOP extension agents. The extensions agents advise the farmers on good agricultural practices, in regards to planting, the application of fertilizer, the tending of rice at its various stages of growth, and post-harvest handling.

The third treatment (T3) provided a contract that included all the attributes of T2 and added the provision of inputs, on loan, from ESOP. The contract stipulated the amount of seed and fertilizer to be provided as well as the price. At the end of the season, the total cost of inputs provided would be deducted from the price paid to the farmers.

In order to increase power to detect effects between the various contracts, our contract treatment arm was three times as large as our pure control. For farmers in the contract treatment, we can view the basic price guarantee contract (T1) as a comparison or control for the contracts that add extension training

[7] Contracts were all written in French. See Appendix A for English language translations of these contracts.
[8] The sale price was 150 CFA equivalent to US$0.27 at an average exchange rate of US$1= 550 CFA during the period of study.

(T2) and input loans (T3). To increase power to detect effects between the more complex contracts, T2 and T3, these treatment arms were approximately twice the size of the T1 comparison group (see Figure 1).

3.3. Balance

Table 2 presents descriptive statistics for our dependent and independent variables for the different treatment groups. The first four columns of the table present means and standard deviations for each treatment and the control at baseline. The final six columns of the table present coefficients and standard errors from OLS regressions comparing households across treatments and with the control. For each cell, we regress the variable of interest (row) on an indicator of treatment status (column). Standard errors are clustered at the farmer-group-level, which is our unit of randomization.

Average rice area for households in the study ranges between 0.6 and 0.8 hectares, with average yields of between 720 and 960 kilograms per hectare but with large standard deviations. Market participation is the only dependent variable where we see differences across multiple treatments. Households randomly assigned to the control and T1 sold about 28 percent of their pre-experiment rice production into the market. By comparison, households randomly assigned to the other two contracts sold about 45 percent of their pre-experiment rice production in the market. Despite this greater share of market participation prior to the experiment, rice income was no different across the four groups, with average income being about US$32 per capita.

Among our control variables, the average household had eight members with the head of the household being around 40 years old. Around 60 percent of households were male headed with the household head having grown rice for around eight years. Only around ten percent of household heads had even a primary education while 90 percent of households listed farming as their primary business or activity. Nearly 100 percent of household heads were members of a farming association. Households did vary in whether or not they had participated in training in rice production. While only around 20 percent of households randomized into T1 had participated in training on rice production, around 60 percent of households in the control and other two treatments had training in rice production.

In addition to checking balance by correlating treatment assignment with each individual outcome variable or household characteristic, we also regress treatment assignment on the complete set of outcome variables and household covariates. Table 2 presents the results from these six regressions as well as the F-stat from a test of joint significance. In general, both of our balance checks suggest that our randomization was effective, though differences do exist across a small number of variables. These differences do not appear to be indicative of systematic variation across multiple treatments and we employ an empirical strategy that allows us to control for where differences exist.

3.4. Attrition

Our experimental designed involved a baseline survey prior to randomization, random assigned at planting, and an endline survey six months later, after harvest. Because of this time delay we did experience attrition among the households in our experiment. Of the 953 households interviewed at baseline, we were unable to follow-up with 98 households, an attrition rate of ten percent. To test for the presence of attrition bias, we compare outcome variables and household covariates at baseline across the returning and attriting households. We also check for systematic differences between attritors and returners within each treatment arm.

As in our balance check, we regress each variable on an indicator for if the household was an attritor, along with arrondissement fixed effects. Columns 1 and 2 of Table 4 present means and standard deviations for attritors and returning households. The following six columns present coefficients and standard errors, clustered at the farmer-group-level, from OLS regressions. For example, the third column displays coefficients and standard errors on an indicator equal to one if the household attrited for the sub-population of households randomized into T1 or the pure control. We find that attriting households had significantly lower income per capita prior to the experiment than returning households. Attritors also tended to be older and less educated, suggesting that they may be less adept at farming than returning households. However, significantly more attritors reported that farming was their primary activity. While some differences do exist the lack of significant differences in the majority of our tests, suggests attrition bias is likely not an issue in our study.

4. Empirical framework

4.1. Expected outcomes

We focus on estimating the direct impacts of randomly assigned farming contracts on four measures of rural transformation: rice area, productivity, market participation, and rice income per capita. To estimate these impacts, we compare potential outcomes for treated households with the potential outcomes in the absence of the treatment. We are not only interested in the effect of being offered a farming contract but the marginal effects of each contract characteristic. As such, we present a large complement of results comparing treatment (any type of contract) to control, comparing each contract to control and comparing differences in outcomes between the various treatment groups.

From our theoretical model, we expect any contract that reduces price uncertainty, increases technical efficiency, or eases capital constraints to positively and significantly affect all four outcome variables. When it comes to expected differences between the impacts of each contract, our theoretical model suggests the effect size will be heterogenous, depending on where the largest gains are to be had for each individual farmer. That said, *a priori* we expect that contracts which address more of the limitations facing farmers will have larger impacts. Because of this, we expect larger and more significant impacts from T3, which embeds a market-specifying, production-management, and resource-providing contract, compared to either of the other two treatments. Similarly, we expect T2, which includes the price guarantee (market-specifying) and the extension training (production-management), to have larger impacts than T1, which only includes the price guarantee.

4.2. Intention to Treat (ITT)

Because we have both baseline and endline data, we can estimate treatment effects using two different approaches. We first estimate the treatment effect using a Simple Mean Difference (SMD) model:

$$y_{ir} = \alpha + \delta_{SMD} T_i + X_{ir}\beta + \rho_r + \epsilon_{ir} \tag{12}$$

where y_{ir} is the outcome of interest for household i in arrondissement r. Let T_i be our indicator of treatment, variously defined, for the household and δ_{SMD} the coefficient on the SMD estimate of the treatment effect. In some specifications we include a vector of household characteristics, X_{ir}, along with arrondissement fixed effects, ρ_r. Lastly, ϵ_{ir}, is an idiosyncratic error term orthogonal to T_i as a result of our randomization.

Our second estimator is an Analysis of Covariance (ANCOVA) estimate of the treatment effect:

$$y_{ir} = \alpha + \delta_{ANCOVA} T_i + \mu y_{ir,PRE} + X_{irt}\beta + \rho_r + \epsilon_{irt}. \tag{13}$$

Here $\mathrm{y_{ir,PRE}}$ is the value of the outcome variable from the pre-treatment 2016-17 growing season and δ_{ANCOVA} is the coefficient on the ANCOVA estimate of the treatment effect. The ANCOVA estimator has more power than the typical Difference-in-Difference (DID) estimator when autocorrelation is low (McKenzie, 2012), which it is in our sample.[9]

4.3. Multiple hypothesis testing

Because we are testing a large number of hypothesis, it is possible that significant results emerge from our analysis due not to actual treatment effects but rather to chance. While the problems arising from multiple inference is well known, dating back to Bonferroni (1935), the literature has yet to arrive at a consensus regarding the best way to correct for multiple hypothesis testing. Some suggest adjusting only when making

[9] The correlation between each of our outcome variables is: rice area (-0.027), productivity (0.023), market participation (0.116), and income per capita (0.063).

inferences for multiple outcomes (Anderson, 2008; Casey et al., 2012; Heckman et al., 2011; Kling et al., 2007) while others suggest correcting only for multiple subgroups (Lee and Shaikh, 2014). Still others suggest correcting for both multiple outcomes and subgroups (Heckman et al., 2010). Both Bonferroni (1935) and Holm (1979) have proposed their own ways to adjust *p*-values to correct for multiple inference. More recently, List et al. (2018) have developed a step-wise multiple testing procedure. Alternatively, Anderson (2008) and Ksoll et al. (2016) use sharpened *q*-values to adjust for multiple hypothesis testing. We take a catholic approach and present results, in Appendix B, from the Bonferroni adjustment, the Holm adjustment, List et al.'s step-wise correction, and Anderson's sharpened *q*-values. Our results are robust across specifications in terms of statistical significance when we adjusted standard errors for multiple hypotheses testing.

5. Results and discussion

5.1. Impact of contract farming on rural transformation

Table 5 presents the treatment effects of a household being randomly assigned any of the three farming contracts on four measures of rural transformation. We present results from SMD and ANOVA regressions, without and with household covariates. In Panel A we present treatment effects on rice area, measured in hectares; in Panel B we present treatment effects on productivity, measured as kilograms of paddy rice harvest per hectare; in Panel C we present treatment effects on market participation, measured as the percentage of harvested rice sold into the market; and in Panel D we present treatment effects on rice income, measured as the value of rice harvest in U.S. dollars divided by household size.

Farmers randomly selected to receive one of the three contracts were provided with the written and signed contract prior to planting, which gave them time to reallocate their own land or rent in more land if they desired. Both the SMD and ANCOVA estimates reveal that farmers with a contract did plant a significant amount of additional land with rice compared to control farmers without a contract. Despite land being a lumpy input, farmers with contracts planted 25 percent more land with rice than control farmers.

Examining results of farming contracts on the other three variables of interest, we also find consistently positive and significant effects. Focusing on the ANCOVA estimates with covariates, being offered a farming contract increases productivity by 473 kg per hectare or about 29 percent higher yields than the control. Households with farming contracts increased their market participation by selling 35 percentage points more of their rice harvest, a 140 percent increase above farmers without contracts. This increased land size, higher productivity, and greater market participation resulted in treated households earning $140 more income per capita, an increase of 230 percent or about 1.8 standard deviations above mean per capita income for the control.

5.2. Impact of contract attributes on rural transformation

While contract farming clearly had a large, positive impact on area planted to rice, productivity, market participation, and income, we are primarily interested in which type of contract is most effective in reducing risks and easing production constraints. In Table 6 we compare households randomly given a contract that provides a price guarantee (T1) with the control group. In Table 7 we compare households randomly offered a contract that provides extension training, in addition to a guaranteed price (T2), with the control group. In Table 8 we compare households randomly offered a contract that provides input loans, in addition to extension training and a price guarantee (T3), with the control group. As previously, we provide SMD and ANCOVA estimates, with and without covariates, of the treatment on rice area, productivity, market participation, and income.

Focusing first on the contract that only offers a guaranteed price, we find positive and significant effects for three of our four variables of interest. Unlike our comparison of any farming contract to the control, we find that households offered the market-specifying contract did not take the opportunity to increase their rice area. While these households did not increase their rice area, we do find an effect of the market-specifying contract on productivity. Households in T1 produced around 450 more kg per hectare, an increase of around 27 percent. We also find that households offered the contract increased their market participation by 20 percentage points and earned on average $56 more per household member.

Table 7 reports results from a comparison of the production-management contract combined with the market-specifying contract. Here we find that farmers offered contracts that provided extension training and a price guarantee had larger areas planted to rice, had higher productivity, greater market participation, and higher incomes than those in the control group. Rice area in the treatment group increased by 14 percent (0.11 ha), while productivity increased by 28 percent (469 kg/ha). In addition to the larger land size and greater productivity, farmers randomly assigned to T2 marketed 32 percent more of there rice harvest (a 128 percent increase), and earned $84 more per household member (an increase of 142 percent). Overall, the magnitude of the effect of T2 compared to the control appears to be larger than the effect of T1 compared to the control, which aligns with our priors. However, we explore these differences in more detail in the next subsection.

The impact of a contract that provides input loans in addition to extension training and a price guarantee are presented in Table 8. Being randomly assigned to T3 has positive and significant effects on all four outcome variables, and the magnitude of the effect size is even larger than those in Table 5, where we compared any farming contract to the control. Farmers given contracts that provided input loans in addition to extension training and a price guarantee increased the area planted to rice by 0.28 hectares, increased the amount of rice produced on a hectare by 504 kg, sold 39 percent more of their rice into the market, and earned $218 more dollars per household member.

5.3. Differences in the impact of contract attributes on rural transformation

Our piecewise comparison of each contract type with the control group demonstrates that there are differences in the impacts contract attributes have on rural transformation. To investigate these differences further, we estimate treatment effects of each treatment, relative to the control, in a single regression. This not only allows us to test for differences between each treatment and the control but also test for differences between one treatment and another. Results from these regressions are presented in Table 9, with Bonferroni-adjusted Wald tests for differences between coefficients on the treatment dummies in Table 10.

The results for each treatment's impact on rice area is similar to the results presented in Tables 6-8, though coefficients are consistently significant due to the gain in power from using the whole sample. All three contracts resulted in households increasing rice area relative to control households. However, testing for differences between the magnitudes of the coefficient reveals that the effect of T1 (market-specifying) is not significantly different from the effect of T3 (resource-providing). By comparison, the effect of T2 (production-management) on area planted to rice is significantly lower than the effect of T3, though not T1. We hypothesis that the provision of input loans lowers the per unit cost of production for farmers, allowing them to expand area planted to rice without increasing their total farm production costs. However, we lack the detailed production data on non-rice crops needed to test this hypothesis.

Turning to each contract's effect on productivity, we find that all three have a positive and significant impact. Yet, a Wald test for differences between each of these coefficients fails to reject the null of equality (Table 10). This suggests that while our experiment had sufficient power to detect differences in yield between each contract and the control, we lack power to detect differences in yield between treatment arms.

Heterogeneity in the effect of each contract becomes obvious when we look at the impact of each type of contract on market participation. All three contracts have a positive and significant impact on market participation. This is to be expected, since each contract provided farmers with a guaranteed buyer for their rice crop. However, unlike rice area or yields, in which each contract returned relatively similar effect sizes, the impact of each contract on market participation significantly differs from each other. Conforming with our priors, effect sizes are greater for contracts that offer more services to the farmer. Those in the T1 treatment sell about 50 percent of their rice harvest into the market (24 percentage points more than the control), while those in T2 sell 56 percent and those in T3 sell 67 percent. The effects of using contracts to integrate farmers into the market are clear. Without a guaranteed buyers, households sell about a quarter of their rice production and keep the remaining three quarters. Under the most generous contract, farmers nearly reverse this ratio, selling almost 70 percent of their rice into the market and retaining only 30 percent.

Unsurprisingly, given that farmers with contracts increase their rice area, their productivity, and their market participation, each contract provides significantly higher income on a per capita basis relative to farmers in the control. But here again, similar to rice area and market participation, returns are heterogeneous based on the terms of the contract. Farmers with the production-management contract (T2) had lower returns to income per capita relative to the other two contracts, though the difference is only statistically significant when compared to the resource-providing contract (T3).

Overall, we find a curious degree of heterogeneity in impacts based on the terms of the contract. Contrary to our priors, it is not always that case that the effect size of T1 is smaller than T2, which is smaller than T3. Instead, we find that the market-specifying contract (T1) increases rice area to the same extent as the resource-providing contract (T3), while the production-management contract (T2) has a smaller effect size. All three contracts have similar effects on yields, meaning that the provisioning of extension training and/or input loans does not result in increased productivity relative to the contract the only provides a price guarantee. For rice income per capita we again find that the added elements of T2 do not seem to provide any additional value over the simple market specifying contract, though the provision of input loans does result in higher income relative to the other two contracts. Throughout the analysis, we frequently find that the magnitude of the coefficient on the T2 treatment is the smallest of the three treatment arms, while the magnitude of the coefficient on the T1 treatment is only slightly less than that on the T3 treatment. In fact, the only outcome variable that conforms to our priors is market participation, where farmers with the production-management contract sell significantly more rice than farmers with the market-specifying contract, and farmers with the resource-providing contract sell significantly more rice than the other two.

5.4. Pairwise comparison of differences in the impact of contract attributes

In the previous subsections we were able to test the treatment effects between each randomly assigned contract and the control, as well as differences between each contract. In an ideal world we would also be able to directly test between each contract characteristic separately, by offering a random set of farmers a contract that just provided extension training and no price guarantee or a contract that provided input loans and nothing else. However, due to the financial constraints of our implementing partner and the need to ensure sufficient power for comparisons between each treatment arm, we were limited to offering only three types of contracts.

In this subsection, we present results from comparing one type of contract with another and interpret the effects as due to the difference in contract attributes. Obviously, identification in this way requires the assumption that each new contract characteristic is additive and independent and expresses no complementarity or substitutability with the other contract attributes. Given this assumption, comparing the market-specifying contract (T1) with the contract that combines the price guarantee and extension training

(T2) should provide the treatment effect of a production-management contract. Similarly, comparing T2 with the contract that also provides input loans (T3) should provide the treatment effect of a resource-providing contract. If the independence assumption does not hold, these comparisons are still informative regarding the differences in treatment effects, similar to those presented in Tables 9 and 10.

Table 11 presents estimates of the treatment effect of adding extension training to a contract by comparing the market-specifying and production-management contract (T2) to the market-specifying contract (T1). Here the differences between the two contracts implied by our previous results become explicit. Providing extension training tends to provide no additional value over the contract that simply guarantees a price. Farmers in T2 had significantly smaller areas planted in rice, significantly greater market participation, and insignificant differences in productivity and income.

In Table 12, we present estimates of the treatment effect of adding input loans to a contract. Here we compare the contract that combines market-specification, production-management, and resource-provision to the contract that provides only the first two. We find that the provision of input loans improves on all four outcomes relative to the base case.

Our final comparison is between the contract that combines market-specification, production-management, and resource-provision with the contract that only offers the price guarantee. Results are presented in Table 13. Here we find the addition of extension training and input loans has no significant effect over providing a price guarantee for rice area and productivity, though there is a significant and positive effect for market participation and rice income.

5.5. Discussion

The results from our field experiment present consistent, though somewhat unexpected, evidence regarding the impact of different farm contract attributes. Participation in contract farming had a positive and significant impact on rice area, productivity, market participation, and rice income. Our overall results also demonstrate that contract farming, at least the contracts ESOP offered to rice farmers in our study, are productivity and income increasing. However, this should not be interpreted as difinitive evidence that all contract farming is beneficial to the agent, as we designed the contracts to be generous to help ensure compliance in the study. That said, the contracting terms regarding compensation were well within the range of contracts ESOP had offered to farmers previous to our study.

While the overall positive effect of a farming contract was expected, we did not anticipate some of the differences in outcomes across contract type. In particular, contracts that provide extension training seemed to dampen incentives. Evidence from comparisons in Tables 7, 9, 10, 11, and 12 all show that the provision of extension training frequently resulted in lower outcomes (though not always significantly lower) relative to the comparison group. As an example, in Table 12, providing input loans increases rice income per capita by $106 but in Table 13 providing input loans in combinations with extension training results in an increase in rice income per capita by only $92. Less directly but with more precison, Table 9 shows that the contract that offered extenion training in addition to a price guarentee but without input loans had to smallest impact on all three of the four outcome variables.

These results may be explained by two factors. First, extension training is expected to increase technical efficiency. However, many smallholder farmers are resource-poor and may be unable to apply the knowledge they have gained. For instance, training regarding best practices for the application of fertilizer when the farmer cannot afford to buy the fertilizer is time ill spent. Second, the farmers in our experiment had very basic levels of education. The extension training developed with ESOP may have been pitched at too high a level to be effective. That extension training was ineffective in our study is disappointing but not abnormal. Both Feder et al. (2010) and Jones and Kondylis (2018) provide evidence that extension services received by farmers in developing countries often prove ineffective in producing positive and significant outcomes for smallholder farmers.[10] Furthermore, in many developing countries, extension services focus more on cash crops (cotton, cocoa, peanut, palm oil, etc.), neglecting staple food crops such as rice (Diagne and Pesche, 1995).

While extension training proved to provide low-powered incentives, contracts that only offered a price guarantee turned out to provide particularly high powered incentives. Across multiple comparison groups, the contract that only provided a price guarnatee resulted in outcomes statistically indistinguishable from the contract that added input loans and extension training to the price guarantee. Focusing on the results in Table 10, the market-specifying contract resulted in a significantly larger positive impact on rice area relative to the other two contracts and the control. The T1 contract provided impacts indistinguishable from the other contracts in terms of rice area, productivity, and rice income. Market participation was the only outcome variable where the market-specifying contract failed to meet or exceed one or more of the other contracts.

This result is striking in its simplicity and enormously encouraging in its implications for contract farming and rural transformation. In contrast to Abebe et al. (2013), who find that farmers in Ethiopia prefer contracts the insulate them from input price risk, our results imply that the primary issue facing smallholders farmers, at least rice farmers in Benin, is output price risk. By providing a contract that eliminates price risk, farmers are able to, on their own, make the necessarily investment to increase their rice area, increase the percentage of output sold into the market, and as a result, increase their farm income. Our results demonstrate experimentally what has long been argued from observational data, that farmers respond to price incentives (Schultz, 1964). For organizations looking to provide contracts to farmers, this result is

[10] See also Bellemare (2010) for the impacts of extension services in the context of contract farming.

encouraging because it implies that they can provide strong incentives to farmers without undertaking the costs of providing training and input loans. By far the most binding constraint to expansion for ESOP is the need to raise sufficient capital to provide input loans to farmers at planting. Our results demonstrate that much of this expense may be unnecessary and ESOP could potentially expand the number of farmers it contracts with, and thus its milling capacity, by only offering farmers a guaranteed price. With a price guarantee delivering market access, farmers can use the contract as collateral to rent in more land and obtain loans for inputs, improving outcomes for both parties and contributing to more rapid rural transformation.

6. Conclusion

The use of contract farming has a long tradition in modern agriculture and has become an increasing topic of discussion in developing country agriculture. Contract farming has been proposed as an engine for rural transformation and not just an outcome from the modernization of agriculture. However, concrete evidence for or against the role of contract farming in rural transformation has been lacking. Previous studies have been exclusively observational, while many studies have attempted to draw causal inference from cross-sectional data. Our study provides the first experimental evidence of the impacts of contract farming in a developing country context.

Our results demonstrate that contract farming has positive and significant impacts on a number of different measures of farm productivity and household welfare and contributes to rural transformation. Of particular interest to both contracting parties, as well as policymakers, are the strong incentives provided by a simple market-specifying contract. The provision of a price guarantee resulted in outcomes frequently indistinguishable from more complex (and more costly) contracts that provided extension training and/or input loans. This suggests that once price uncertainty is resolved, farmers are able to, on their own, address issues of technical efficiency and capital constraints.

A caveat, as with any experimental study, is that the external validity of our results may be limited. Yet, we believe that our experiment provides a context and setting more generalizable than most observational studies of contract farming. Observational studies have frequently focused on high-value of specialty crops, cultivated by a small number of farmers relative to the number cultivating staple crops. In comparison, we study contract farming for a staple grain. Unlike specialty crops, the margins, and therefore the incentives, for staple crop cultivation are small, even given the generous terms of the contracts offered to farmers by ESOP. This suggests that our results should not only be generalizable to contract farming for other staple crops but may be a lower bound on the impacts that contract farming has on specialty crops.

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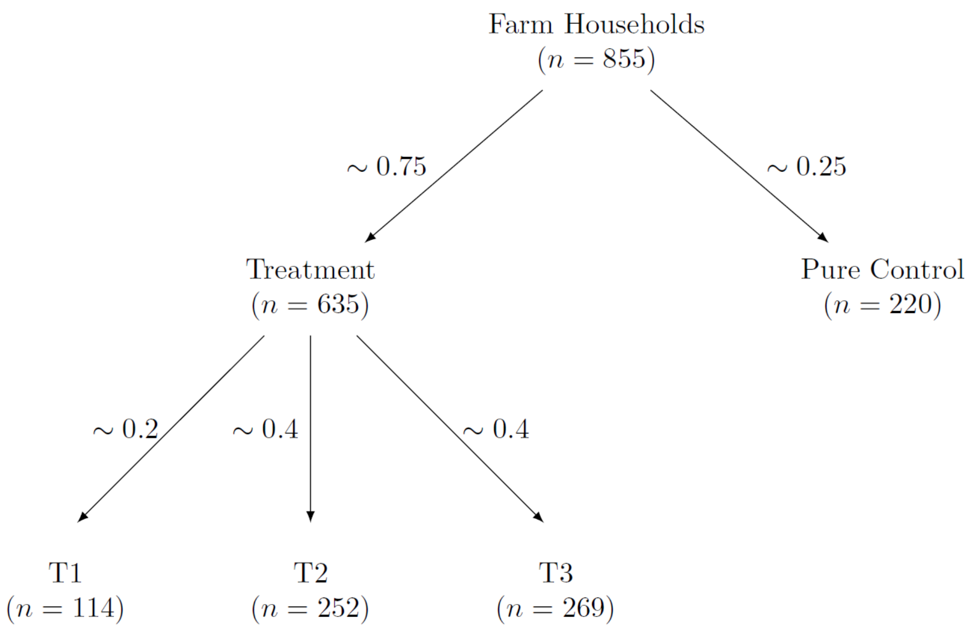
Figure 1: Design of experiment



Note: The experimental design randomized 855 farmers into treatment and control at a ratio of (approximately) 3:1. All farmers in the treatment were offered an production contract that specified the price, quantity, quality, and variety of rice plus the date, location, and bag size for pickup. The 635 farmers in the treatment group were then randomized into two treatment contracts and a control contract at a ratio of (approximately) 2:1. Farmers in T1 received nothing in addition to the control contract. Farmers in the second group (T2), received the control contract combined with extension training. Farmers in the third group (T3), received a contract that combined T2 with input loans. The specific quantity of the loans depended on each farmer's planned production. Randomization across all treatment arms occurred at the farmer-group level with contracts being signed with individual farmers in each group.

Table 1: Attributes of existing contract farming arrangements

		Number	Percentage
Awareness of contract farming		745	87.13
Experience in contract farming		605	70.75
Type of contract	Oral	779	91.15
	Written	76	8.85
Agreement on price		281	32.86
Agreement on quality		707	82.67
Agreement on quantity		342	40.01
Technical training/backstopping		379	44.29
Credit	In-kind credit	134	15.71
	In-cash credit	98	11.43
	Consumption credit	12	1.43

Note: Table displays number of households and percentage of household in the data set that responded in the affirmative to questions regarding their awareness of and experience with contract farming.

Table 2: Baseline summary statistics and balance test

	Control (n=220)	Price [T1] (n=114)	Extension & price [T2] (n=252)	Input loans, extension, & price [T3] (n=269)	Differences in treatment status within groups					
					[T1 & C]	[T2 & C]	[T3 & C]	[T2 & T1]	[T3 & T1]	[T3 & T2]
Rice area (ha)	0.624	0.610	0.795	0.683	-0.014	0.171	0.059	0.185	0.073	-0.112
	(0.735)	(0.662)	(0.764)	(0.736)	(0.080)	(0.106)	(0.102)	(0.106)	(0.103)	(0.122)
Productivity (kg/ha)	722.8	744.0	958.9	890.2	21.18	236.0	167.4	214.9	146.2	-68.67
	(1,036)	(1,249)	(1,232)	(1,223)	(220.7)	(216.7)	(198.0)	(279.7)	(261.6)	(261.5)
Market participation	28.83	25.75	45.80	44.36	-3.082	16.97*	15.53*	20.05*	18.62*	-1.437
(%)	(38.16)	(36.80)	(41.75)	(41.99)	(5.587)	(7.502)	(6.840)	(7.892)	(7.284)	(8.780)
Rice income	35.54	32.29	30.31	31.23	-3.251	-5.231	-4.316	-1.980	-1.065	0.915
per cap (US$)	(109.7)	(109.5)	(59.57)	(67.25)	(15.39)	(10.68)	(11.11)	(15.50)	(15.29)	(11.21)
Household size	8.818	7.702	8.163	8.089	-1.116	-0.655	-0.729	0.461	0.387	-0.073
	(4.386)	(3.699)	(3.663)	(3.861)	(0.608)	(0.510)	(0.461)	(0.710)	(0.670)	(0.567)
Age of household	40.56	42.22	41.51	39.75	1.665	0.953	-0.807	-0.711	-2.472	-1.761
head (years)	(8.972)	(10.29)	(10.32)	(10.54)	(1.390)	(1.139)	(1.101)	(1.562)	(1.530)	(1.276)
Male headed	0.564	0.640	0.488	0.591	0.077	-0.076	0.027	-0.152	-0.049	0.103
household (=1)	(0.497)	(0.482)	(0.501)	(0.493)	(0.080)	(0.071)	(0.063)	(0.086)	(0.079)	(0.067)
Exp. Producing rice	8.195	7.833	9.679	7.974	-0.362	1.483	-0.221	1.845	0.141	-1.705
(years)	(3.593)	(5.603)	(5.711)	(4.747)	(1.223)	(0.808)	(0.653)	(1.426)	(1.338)	(0.967)
Primary education	0.114	0.096	0.123	0.093	-0.017	0.009	-0.021	0.027	-0.004	-0.030
(=1)	(0.318)	(0.297)	(0.329)	(0.291)	(0.032)	(0.024)	(0.025)	(0.031)	(0.030)	(0.024)
Farming is main	0.918	0.947	0.913	0.918	0.029	-0.005	0.000	-0.035	-0.029	0.006
activity (=1)	(0.275)	(0.224)	(0.283)	(0.275)	(0.036)	(0.031)	(0.032)	(0.040)	(0.040)	(0.035)
Training in rice	0.527	0.193	0.627	0.550	-0.334***	0.100	0.023	0.434***	0.357***	-0.077
production (=1)	(0.500)	(0.396)	(0.485)	(0.498)	(0.063)	(0.084)	(0.090)	(0.091)	(0.095)	(0.111)
Member of farm	0.968	0.921	0.976	0.974	-0.047	0.008	0.006	0.055	0.053	-0.002
association (=1)	(0.176)	(0.271)	(0.153)	(0.159)	(0.034)	(0.020)	(0.016)	(0.036)	(0.031)	(0.020)

Note: The first four columns report means of the data at baseline with standard deviations in parenthesis. The final six columns report coefficients and standard errors from SMD regressions of the variables of interest or the covariates on treatment status within different groups. Standard errors clustered at the farmer-group-level are in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 3: Balance test across treatments

	Differences in treatment status within groups					
	[T1 & C]	[T2 & C]	[T3 & C]	[T2 & T1]	[T3 & T1]	[T3 & T2]
Rice area (ha)	0.045	0.104*	0.022	0.060	-0.018	-0.093
	(0.044)	(0.045)	(0.048)	(0.047)	(0.047)	(0.053)
Productivity (kg/ha)	0.000	0.000	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Market participation (%)	-0.000	0.002	0.003**	0.002*	0.002*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Income (US$/ha)	-0.000	-0.001***	-0.001*	-0.001**	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Household size	-0.014	-0.017*	-0.013	0.014	0.012	0.002
	(0.007)	(0.007)	(0.007)	(0.008)	(0.010)	(0.010)
Age of household head	0.006	-0.000	-0.002	-0.008**	-0.007*	-0.001
(years)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
Male headed household	0.086	-0.082	0.036	-0.159*	-0.049	0.141*
(=1)	(0.068)	(0.071)	(0.064)	(0.066)	(0.066)	(0.065)
Experience producing rice	-0.004	0.016*	-0.001	0.012	0.004	-0.013
(years)	(0.012)	(0.007)	(0.009)	(0.008)	(0.010)	(0.009)
Primary education (=1)	0.009	0.023	-0.077	0.025	-0.039	-0.074
	(0.078)	(0.063)	(0.066)	(0.072)	(0.088)	(0.061)
Farming is main activity	0.108	-0.067	-0.002	-0.119	-0.051	0.038
(=1)	(0.126)	(0.087)	(0.099)	(0.109)	(0.120)	(0.100)
Training in rice production	-0.308***	0.064	-0.011	0.375***	0.255**	-0.051
(=1)	(0.075)	(0.078)	(0.088)	(0.083)	(0.085)	(0.109)
Member of farm assoc.	-0.237	0.098	0.111	0.159	0.259	0.043
(=1)	(0.125)	(0.196)	(0.150)	(0.203)	(0.137)	(0.210)
Observations	334	472	489	366	383	521
F-test of joint significance	3.81	4.19	3.34	5.89	2.91	1.30

Note: Each column reports coefficients and standard errors from an SMD regression of treatment status on all baseline characteristics. Test of joint significance reports F-stat on the null that all coefficients are jointly equal to zero. Standard errors clustered at the farmer-group-level in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 4: Baseline differences between attrited and returning households

	Returning (n=855)	Attrited (n=98)	Differences between attrited and returning households within groups					
			[T1 & C]	[T2 & C]	[T3 & C]	[T2 & T1]	[T3 & T1]	[T3 & T2]
Rice area (ha)	0.691	0.693	-0.017	0.011	-0.111	0.011	-0.019	0.141
	(0.737)	(0.629)	(0.099)	(0.093)	(0.083)	(0.112)	(0.149)	(0.139)
Productivity (kg/ha)	847.9	599.1	-134.7	-213.3	-145.2	-319.7*	-302.8	-316.8
	(1,186)	(821.0)	(137.4)	(141.9)	(182.8)	(161.1)	(197.3)	(209.9)
Market participation (%)	38.31	38.14	9.922	-0.633	-2.261	-0.256	0.667	-5.993
	(41.12)	(42.41)	(6.262)	(6.268)	(7.356)	(7.336)	(9.192)	(10.54)
Rice income per capita (US$)	32.21	15.27	-18.56*	-14.76*	-10.48	-18.48**	-20.39**	-16.76*
	(84.48)	(35.75)	(8.941)	(7.463)	(11.72)	(6.788)	(7.276)	(6.928)
Household size	8.247	8.378	-0.422	-0.028	-0.788	0.643	0.308	1.000
	(3.937)	(4.078)	(0.693)	(0.691)	(0.760)	(0.694)	(0.934)	(1.066)
Age of household head (years)	40.80	44.44	1.938	3.360*	0.927	4.003**	3.979*	6.682**
	(10.08)	(11.08)	(1.294)	(1.689)	(1.582)	(1.551)	(1.598)	(2.413)
Male headed household (=1)	0.560	0.571	-0.060	0.070	-0.060	0.056	-0.067	0.115
	(0.497)	(0.497)	(0.078)	(0.072)	(0.098)	(0.081)	(0.110)	(0.093)
Experience producing rice (years)	8.515	9.337	0.610	-0.055	-1.222	1.178	2.017*	1.889
	(4.970)	(5.841)	(0.868)	(0.856)	(1.076)	(0.793)	(1.010)	(1.395)
Primary education (=1)	0.108	0.051	-0.093***	-0.051	-0.102***	-0.044	-0.068*	0.018
	(0.310)	(0.221)	(0.020)	(0.038)	(0.012)	(0.034)	(0.027)	(0.062)
Farming is main activity (=1)	0.920	0.969	0.042	0.068**	0.082***	0.034	0.022	0.053
	(0.271)	(0.173)	(0.026)	(0.022)	(0.017)	(0.029)	(0.031)	(0.033)
Training in rice production (=1)	0.519	0.429	-0.080	-0.140	-0.318***	0.015	-0.034	0.038
	(0.500)	(0.497)	(0.081)	(0.074)	(0.079)	(0.095)	(0.121)	(0.127)
Member of farm assoc. (=1)	0.966	0.959	-0.013	-0.023	-0.082	0.027	0.016	0.025*
	(0.181)	(0.199)	(0.032)	(0.035)	(0.062)	(0.021)	(0.030)	(0.010)

Note: The first two columns report means of the data at baseline with standard deviations in parenthesis. The final six columns report coefficients and standard errors from SMD regressions of the variables of interest or the covariates on attrition status within different groups. Standard errors clustered at the farmer-group-level are in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 5: Treatment effects of farming contract [T-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.199***	0.179***	0.199***	0.178***
	(0.055)	(0.057)	(0.055)	(0.057)
Mean dependent variable in control	0.772			
Observations	855	855	855	855
R-squared	0.06	0.07	0.06	0.07
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	466.9***	480.2***	459.0***	472.5***
	(98.08)	(106.2)	(98.03)	(105.8)
Mean dependent variable in control	1,652			
Observations	855	855	855	855
R-squared	0.09	0.09	0.09	0.10
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	32.95***	34.79***	32.97***	34.83***
	(2.634)	(2.433)	(2.664)	(2.440)
Mean dependent variable in control	24.96			
Observations	855	855	855	855
R-squared	0.49	0.50	0.49	0.50
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel D: rice income per capita (US$)				
Treatment effect	128.7***	139.6***	132.8***	139.3***
	(32.44)	(32.05)	(32.64)	(32.64)
Mean dependent variable in control	60.70			
Observations	855	855	855	855
R-squared	0.13	0.25	0.13	0.25
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 6: Treatment effects of price guarantee [T1-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.139**	0.040	0.141**	0.037
	(0.064)	(0.095)	(0.066)	(0.095)
Mean dependent variable in control	0.772			
Observations	334	334	334	334
R-squared	0.13	0.15	0.13	0.15
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	603.9***	455.2***	601.4***	447.3***
	(145.1)	(164.5)	(144.2)	(161.6)
Mean dependent variable in control	1,652			
Observations	334	334	334	334
R-squared	0.16	0.18	0.16	0.18
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	20.36***	20.05***	19.57***	19.40***
	(2.413)	(2.844)	(2.408)	(2.779)
Mean dependent variable in control	24.96			
Observations	334	334	334	334
R-squared	0.49	0.50	0.49	0.50
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel D: rice income per capita (US$)				
Treatment effect	56.15***	55.92**	61.26***	56.33**
	(14.13)	(23.95)	(15.27)	(24.74)
Mean dependent variable in control	60.70			
Observations	334	334	334	334
R-squared	0.34	0.44	0.34	0.44
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 7: Treatment effects of extension training and price guarantee [T2-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.131***	0.111**	0.139***	0.110**
	(0.030)	(0.044)	(0.041)	(0.045)
Mean dependent variable in control	0.772			
Observations	472	472	472	472
R-squared	0.03	0.07	0.06	0.07
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	443.9***	471.6***	441.9***	469.0***
	(97.45)	(78.01)	(97.90)	(76.93)
Mean dependent variable in control	1,652			
Observations	472	472	472	472
R-squared	0.10	0.12	0.10	0.12
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	32.32***	32.17***	32.12***	31.95***
	(2.395)	(2.356)	(2.167)	(2.269)
Mean dependent variable in control	24.96			
Observations	472	472	472	472
R-squared	0.58	0.59	0.58	0.59
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel D: rice income per capita (US$)				
Treatment effect	78.55***	84.45***	83.05***	83.87***
	(15.36)	(14.73)	(15.93)	(14.94)
Mean dependent variable in control	60.70			
Observations	472	472	472	472
R-squared	0.14	0.27	0.15	0.27
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 8: Treatment effects of input loans, extension training, and price guarantee [T3-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.258***	0.278***	0.312***	0.281***
	(0.033)	(0.088)	(0.086)	(0.088)
Mean dependent variable in control	0.772			
Observations	489	489	489	489
R-squared	0.09	0.13	0.12	0.13
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	509.1***	509.6***	505.1***	503.6***
	(143.6)	(168.9)	(140.5)	(164.6)
Mean dependent variable in control	1,652			
Observations	489	489	489	489
R-squared	0.14	0.16	0.14	0.16
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	37.75***	38.76***	37.75***	38.77***
	(2.902)	(2.794)	(2.906)	(2.795)
Mean dependent variable in control	24.96			
Observations	489	489	489	489
R-squared	0.68	0.69	0.68	0.69
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel D: rice income per capita (US$)				
Treatment effect	222.8***	218.8***	224.2***	218.2***
	(53.40)	(47.82)	(53.50)	(48.17)
Mean dependent variable in control	60.70			
Observations	489	489	489	489
R-squared	0.22	0.34	0.22	0.34
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 9: Treatment effects of each contract characteristic [T3-T2-T1-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect of T1	0.236***	0.227***	0.251***	0.227***
	(0.044)	(0.067)	(0.068)	(0.068)
Treatment effect of T2	0.131***	0.118**	0.137***	0.117**
	(0.030)	(0.051)	(0.048)	(0.051)
Treatment effect of T3	0.258***	0.242***	0.261***	0.243***
	(0.033)	(0.067)	(0.064)	(0.067)
Mean dependent variable in control	0.772			
Observations	855	855	855	855
R-squared	0.06	0.08	0.08	0.08
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect of T1	507.3***	499.0***	494.7***	485.7***
	(127.5)	(146.5)	(128.1)	(146.3)
Treatment effect of T2	393.3***	418.4***	387.3***	412.5***
	(102.8)	(112.2)	(102.6)	(111.8)
Treatment effect of T3	550.0***	552.1***	542.1***	543.8***
	(112.3)	(120.4)	(111.3)	(118.8)
Mean dependent variable in control	1,652			
Observations	855	855	855	855
R-squared	0.09	0.10	0.09	0.10
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect of T1	22.27***	23.85***	22.28***	23.86***
	(2.765)	(2.599)	(2.748)	(2.578)
Treatment effect of T2	30.59***	31.29***	30.59***	31.29***
	(2.325)	(2.166)	(2.330)	(2.167)
Treatment effect of T3	40.12***	41.63***	40.12***	41.63***
	(2.363)	(2.139)	(2.364)	(2.131)
Mean dependent variable in control	24.96			
Observations	855	855	855	855
R-squared	0.54	0.55	0.54	0.55
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes
Panel D: rice income per capita (US$)				
Treatment effect of T1	126.2***	122.8***	128.6***	122.7***
	(32.42)	(32.58)	(32.32)	(32.80)
Treatment effect of T2	81.31***	95.63***	85.71***	95.38***
	(23.20)	(26.82)	(23.77)	(27.18)
Treatment effect of T3	193.0***	197.6***	196.9***	197.3***
	(36.07)	(33.78)	(36.22)	(34.22)
Mean dependent variable in control	60.70			
Observations	855	855	855	855
R-squared	0.17	0.29	0.17	0.29
Arrondissement FE	Yes	Yes	Yes	Yes
Household covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 10: Wald tests for differences between coefficients

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Difference between T2 & T1	0.0723*	0.1053	0.0776*	0.1023
Difference between T3 & T2	0.0023***	0.0093***	0.0091***	0.0079***
Difference between T3 & T1	1.000	1.000	1.0000	1.0000
All pairwise comparisons	0.0016***	0.0080***	0.0061***	0.0069***
Panel B: productivity (kg/ha)				
Difference between T2 & T1	0.6688	1.0000	0.7439	1.0000
Difference between T3 & T2	0.1571	0.2860	0.1513	0.2828
Difference between T3 & T1	1.0000	1.0000	1.0000	1.0000
All pairwise comparisons	0.1292	0.2424	0.1295	0.2430
Panel C: market participation (%)				
Difference between T2 & T1	0.0003***	0.0010***	0.0003***	0.0010***
Difference between T3 & T2	0.0000***	0.0000***	0.0000***	0.0000***
Difference between T3 & T1	0.0000***	0.0000***	0.0000***	0.0000***
All pairwise comparisons	0.0000***	0.0000***	0.0000***	0.0000***
Panel D: rice income per capita (US$)				
Difference between T2 & T1	0.2346	0.6276	0.2632	0.6170
Difference between T3 & T2	0.0000***	0.0000***	0.0000***	0.0000***
Difference between T3 & T1	0.0738*	0.0129***	0.0645*	0.0133***
All pairwise comparisons	0.0000***	0.0000***	0.0000***	0.0000***

Note: Each cell contains the Bonferroni-adjusted p-values for Wald tests between coefficient estimates reported in Table 9. Significance of the test is reported as *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 11: Treatment effects of extension training [T2-T1]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	-0.116**	-0.115**	-0.116**	-0.117**
	(0.052)	(0.056)	(0.053)	(0.056)
Mean dependent variable in control	1.008			
Observations	366	366	366	366
R-squared	0.04	0.05	0.04	0.05
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	-164.9	-110.6	-151.1	-99.34
	(99.98)	(110.64)	(101.4)	(110.2)
Mean dependent variable in control	2,133			
Observations	366	366	366	366
R-squared	0.04	0.05	0.04	0.05
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	10.41***	8.949***	10.31***	8.729***
	(2.161)	(2.122)	(2.137)	(2.117)
Mean dependent variable in control	51.13			
Observations	366	366	366	366
R-squared	0.09	0.12	0.09	0.12
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel D: rice income per capita (USD$)				
Treatment effect	-35.67	-22.21	-33.46	-20.10
	(24.69)	(22.32)	(23.96)	(21.39)
Mean dependent variable in control	190.3			
Observations	366	366	366	366
R-squared	0.11	0.21	0.11	0.22
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 12: Treatment effects of input loans [T3-T2]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.127***	0.129***	0.134***	0.132***
	(0.037)	(0.040)	(0.040)	(0.040)
Mean dependent variable in control	0.904			
Observations	521	521	521	521
R-squared	0.02	0.05	0.04	0.05
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	167.0**	160.1**	164.4**	155.9**
	(79.68)	(79.68)	(77.13)	(76.92)
Mean dependent variable in control	2,036			
Observations	521	521	521	521
R-squared	0.04	0.05	0.04	0.06
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	9.794***	10.86***	9.834***	10.88***
	(1.502)	(1.637)	(1.504)	(1.634)
Mean dependent variable in control	57.25			
Observations	521	521	521	521
R-squared	0.12	0.156	0.13	0.16
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel D: rice income per capita (USD$)				
Treatment effect	117.2***	106.1***	116.7***	106.1***
	(23.44)	(18.83)	(23.47)	(18.85)
Mean dependent variable in control	146.5			
Observations	521	521	521	521
R-squared	0.09	0.23	0.09	0.23
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 13: Treatment effects of input loans and extension training [T3-T1]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Treatment effect	0.024	0.023	0.024	0.023
	(0.047)	(0.048)	(0.048)	(0.049)
Mean dependent variable in control	1.007			
Observations	383	383	383	383
R-squared	0.03	0.04	0.03	0.04
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel B: productivity (kg/ha)				
Treatment effect	121.0	112.7	118.0	109.4
	(101.3)	(108.9)	(99.84)	(106.8)
Mean dependent variable in control	2,133			
Observations	383	383	383	383
R-squared	0.04	0.06	0.04	0.07
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel C: market participation (%)				
Treatment effect	17.05***	16.75***	16.76***	16.40***
	(2.030)	(2.072)	(1.975)	(1.994)
Mean dependent variable in control	51.13			
Observations	383	383	383	383
R-squared	0.21	0.23	0.22	0.24
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes
Panel D: rice income per capita (USD$)				
Treatment effect	69.34**	90.78***	73.25**	92.22***
	(29.97)	(24.85)	(30.45)	(25.34)
Mean dependent variable in control	190.3			
Observations	383	383	383	383
R-squared	0.07	0.25	0.08	0.25
Arrondissement FE	Yes	Yes	Yes	Yes
Household Covariates	No	Yes	No	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Appendix A: Translations of farming contracts

The following are English translations of the three contracts ESOP offered, at random, to farmers in the study. The first contract only provides a price guarantee. The second contract combines the price guarantee with extension training. The third contract adds the provision of seed and fertilizer to the price guarantee and extension training.

CONTRACT

Object of Contract: Production of rice paddy by …………………………………
for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 will not provide any input to the production by Partner 2

Clause 5: Partner 1 will not provide any technical or training assistance to Partner 2

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..…FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at …………..…………FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of ……….…………. in the year of ……………………..
Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last ……......….months from ..…/…../……

Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ………………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

CONTRACT

Object of Contract: Production of rice paddy by ……………………………… for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 will not provide any input to the production by Partner 2

Clause 5: Partner 1 is committed to training Partner 2 on the following topics: agricultural contracts, rice production techniques, farm management, and calculating the cost of rice production

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..….FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at ………….………….FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of ……….…………. in the year of ……………………..

Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last …….......…..months from ...…/…../……
Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ………………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

CONTRACT

Object of Contract: Production of rice paddy by …………………………………
for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 is committed to providing seed (……..……….kilograms) and fertilizer (……..……….kilograms) for Partner 2

Clause 5: Partner 1 is committed to training Partner 2 on the following topics: agricultural contracts, rice production techniques, farm management, and calculating the cost of rice production

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..….FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at ………..…..……….FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of ……….…………. in the year of ……………………..
Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last ……........…..months from ...…/…../……
Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ………………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

Appendix B: Corrections for multiple hypothesis tests

Table 14: Correction for multiple inference of the treatment effects of farming contract [T-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0005	0.0024	0.0005	0.0025
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0003			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0007			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0010			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 15: Correction for multiple inference of the treatment effects of price guarantee [T1-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0344	0.6792	0.0394	0.6988
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0007			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0170	0.0960	0.0180	0.0960
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.0001	0.0079	0.0001	0.0079
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0003			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0070	0.0010	0.0010
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0002	0.0236	0.0002	0.0271
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0010			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0140	0.0010	0.0140

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 16: Correction for multiple inference of the treatment effects of extension training and price guarantee [T2-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0010	0.0151	0.0013	0.0177
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0003			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0030	0.0010	0.0030
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0007			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0010			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 17: Correction for multiple inference of the treatment effects of input loans, extension training, and price guarantee [T3-C]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0005	0.0023	0.0005	0.0021
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0010			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.0007	0.0036	0.0006	0.0032
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0007			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0003			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 18: Treatment effects of each contract characteristic [T3-T2-T1-C]

		SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)					
Treatment effect of T1	Unadjusted *p*-value	0.0003	0.0010	0.0003	0.0011
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0017			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0049	0.0223	0.0053	0.0236
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0013			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0004	0.0001	0.0004
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0003			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel B: productivity (kg/ha)					
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0009	0.0002	0.0012
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0007			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0002	0.0003	0.0003	0.0004
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0020			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0010			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel C: market participation (%)					
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0027			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0040			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0460	0.0010
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0037			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)					
Treatment effect of T1	Unadjusted *p*-value	0.0002	0.0003	0.0001	0.0003
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0030			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0007	0.0005	0.0005	0.0007
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0033			
	List et al. adjusted *p*-value	0.0003			

	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040			
	Holm adjusted *p*-value	0.0023			
	List et al. adjusted *p*-value	0.0003			
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 19: Correction for multiple inference of the treatment effects of extension training [T2-T1]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0306	0.0438	0.0328	0.0435
Bonferroni adjusted *p*-value	0.1220			
Holm adjusted *p*-value	0.0840			
List et al. adjusted *p*-value	0.0767			
Sharpened *q*-value	0.0710	0.0710	0.0710	0.0710
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.1057	0.3228	0.1428	0.3718
Bonferroni adjusted *p*-value	1.0000			
Holm adjusted *p*-value	0.3183			
List et al. adjusted *p*-value	0.3183			
Sharpened *q*-value	0.1040	0.2280	0.1280	0.2290
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0002
Bonferroni adjusted *p*-value	0.0040			
Holm adjusted *p*-value	0.0040			
List et al. adjusted *p*-value	0.0030			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.1551	0.3248	0.1692	0.3521
Bonferroni adjusted *p*-value	0.2013			
Holm adjusted *p*-value	0.1007			
List et al. adjusted *p*-value	0.0953			
Sharpened *q*-value	0.1280	0.2280	0.1280	0.2290

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 20: Correction for multiple inference of the treatment effects of input loans [T3-T2]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.0017	0.0020	0.0013	0.0015
Bonferroni adjusted *p*-value	0.0040			
Holm adjusted *p*-value	0.0020			
List et al. adjusted *p*-value	0.0017			
Sharpened *q*-value	0.0020	0.0020	0.0020	0.0020
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.0404	0.0490	0.0372	0.0472
Bonferroni adjusted *p*-value	0.1080			
Holm adjusted *p*-value	0.0270			
List et al. adjusted *p*-value	0.0270			
Sharpened *q*-value	0.0120	0.0130	0.0120	0.0130
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0010			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains p- or q-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calculated using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.

Table 21: Correction for multiple inference of the treatment effects of input loans and extension training [T3-T1]

	SMD (1)	SMD (2)	ANCOVA (3)	ANCOVA (4)
Panel A: rice area (ha)				
Unadjusted *p*-value	0.6176	0.6313	0.6191	0.6339
Bonferroni adjusted *p*-value	1.0000			
Holm adjusted *p*-value	0.6160			
List et al. adjusted *p*-value	0.6160			
Sharpened *q*-value	0.4650	0.4650	0.4650	0.4650
Panel B: productivity (kg/ha)				
Unadjusted *p*-value	0.2380	0.3056	0.2430	0.3105
Bonferroni adjusted *p*-value	1.0000			
Holm adjusted *p*-value	0.7360			
List et al. adjusted *p*-value	0.6010			
Sharpened *q*-value	0.2420	0.2620	0.2420	0.2620
Panel C: market participation (%)				
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0003			
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010
Panel D: rice income per capita (USD$)				
Unadjusted *p*-value	0.0249	0.0006	0.0199	0.0006
Bonferroni adjusted *p*-value	0.0173			
Holm adjusted *p*-value	0.0013			
List et al. adjusted *p*-value	0.0120			
Sharpened *q*-value	0.0330	0.0020	0.0300	0.0020

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the calculations do not accommodate the presence of covariates or other controls.