Contract Farming: Selection and Spillovers

Molly Ingram*

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Abstract

Contract farming participation is endogenous due to choices made by the organization offering a contract and the farmer individual or group considering a contract. This paper presents a model of this multi-stage selection problem that is consistent with empirical regularities observed in the literature. The model highlights how information asymmetries reduce the size of a contract farming scheme, how contracting organizations may leverage groups to overcome these information asymmetries and other risks, and identifies a new channel for spillovers to farmers who do not participate in contract farming but live in villages with other farmers that participate in contract farming. I then take the model implications for farming households to data collected from 2017 to 2019 in the area of a maize contract farming scheme in Mozambique. I find that both contracted farmers and non-contracted farmers from villages with contracted farmers earn approximately 11% more in price per kilogram of maize than farmers in areas where no one contracts. The price increase leads to contracted and non-contracted farmers within the contracting region earning more from maize sales, and the maize income effect for residing within the contracting region without contracting is nearly 75% of the effect for contracting. However, household incomes do not differ overall across contracting status or contracting region, which may be a result of contracted households reducing the amount of labor they supply on the wage labor market.

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*email: msi34@cornell.edu, Cornell University

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1 Introduction

The agricultural sector accounts for a large portion of the global population and around two-thirds of the population in many low-income countries. In rural areas especially, households participate either fully or partially in the agricultural sector, but they participate in agricultural markets at lower rates. Finding ways to reduce barriers to market participation and provide welfare-enhancing participation opportunities is a goal of researchers, policy makers, and development practitioners. The prevalence of agricultural value chains is increasing in low- and middle-income countries, providing more opportunities for farmers to become part of formal and higher-value markets (Barrett, Reardon, et al. forthcoming). To what extent participation in agricultural value chains can lift households out of poverty is an important open question that has motivated a large literature on market participation and farmer welfare.

Contract farming is an agreement made at the beginning of the agricultural season between a farmer, or farmer group, and an aggregator in which the aggregator promises to purchase crops from the farmer post-harvest and the farmer promises to sell to the aggregator[1]. While the most basic form of contract farming is a simple procurement or marketing contract, there are often additional terms. Many contract farming arrangements (CFAs) provide farmers some combination of access to credit, capital inputs, technical assistance, and price premiums (Ton et al. 2018). By participating in CFAs, aggregators can secure input quantity and quality levels needed for their operations. Although CFAs can benefit both firms and farmers, there are significant transaction costs associated with contract farming. Aggregators and farmers are subject to unenforceable contracts, uncertainty, and information asymmetries around price risk, output risk, and default risk (Barrett, Bachke, et al. 2012). These costs result in a constrained Pareto efficient equilibrium.

Most studies of contract farming find positive welfare effects of participation (Bellemare and Bloem 2018, Ton et al. 2018). However, the literature faces some limitations. Selection bias is a concern for identification of causal impacts of contract farming. Participation is endogenous, due to choices made by both the farmer and the aggregator, and much of the literature relies on cross-sectional data using various methods to control for observable and unobservable differences between farmers (Bellemare and Bloem 2018). Identification of spillovers from contract farming is another limitation in the current literature (Ton et al.

[1] An aggregator could be an exporting firm, a processor, a non-profit organization, or other entity.

2018). Some studies have attempted to identify spillovers to the non-contracted farmers, but many do not or cannot because data is often collected from contracted and non-contracted households within the same location. Potential channels for spillovers to non-contracted households identified to date are labor markets (Neven et al. 2009, Rao and Qaim 2013, Meemken and Bellemare 2020 and product innovation (Schipmann and Qaim 2010). There may also be spillovers within households (Minten, Randrianarison, and Swinnen 2007, Bellemare 2018).

This paper's contribution to the contract farming literature is two-fold, empirical and theoretical. Empirically, I use data, collected with a unique sampling strategy, from Mozambican households that allows for estimation of spillover effects to non-contracted households who live in villages with contracted households. I identify a new channel for spillovers via spot market purchases by the contracting organization that arise from the fixed costs aggregators face. This channel creates sizeable benefits for non-contracted households through maize sales. Households within the region where the contract firm works earn approximately 11% more in price per kilogram of maize than farmers outside of the contracting region, regardless of contracting status. This price increase leads to contracted and non-contracted farmers within the contracting region earning more from maize sales. The maize income effect for residing within the contracting region is nearly three times the size of the effect from contracting.

Theoretically, I develop a model of contract farming from the firm's decision of procurement location to the household's production and post-harvest decisions. The model is consistent with many empirical realities observed in the existing literature and in the context of the Mozambican contract farming scheme studied here. The model makes explicit where selection bias enters the problem and which channels of income generation are affected directly and indirectly by participation in contract farming, as well as how living near contracting households may affect non-contracting households.

Much of the previous literature implicitly interprets evidences through the lens of risk aversion, transaction costs, contract theory, and others, but there is value in having an explicit common framework. Such a framework allows for different empirical settings to be evaluated and compared systematically. Additionally, this paper contributes to the understanding of selection effects and spillovers by modeling a contract choice problem faced by heterogeneous farmers and a contracting firm which embeds the following common problems that firms and farmers face in CFAs: (i) price risk, (ii) asymmetric information, (iii) complex, multi-level selection effects, and (iv) learning or other one-off costs. The results of the model are then used to draw out implications for (a) farmer welfare, (b)inferences made in standard impact evaluations that ignore spillover effects, and (c) the possibility of Pareto-improving subsidies to help resolve costly asymmetric information.

2 Program and Aggregator Description

From 2017 to 2019, the World Bank, in collaboration with the Let's Work Partnership, a group of governmental and non-governmental public organizations, administered the Mozambique Agricultural Aggregator Pilot (MAAP). MAAP was developed to evaluate contract farming's potential for poverty reduction through employment and income effects. The objective of the program was to identify several agricultural aggregators – organizations that buy agricultural products from many small farmers and move the products downstream in the supply chain, hence aggregating the supply – and induce the aggregators to expand or intensify their relationships with farmers via a participation incentive payment. Out of 45 potential aggregators identified within Mozambique, 14 submitted applications to participate in MAAP and seven completed the program[2]. As part of MAAP, aggregators agreed to expand or intensify of their contract farming or "outgrower" system to be funded via internal resources and a MAAP participation incentive payment. Also as part of MAAP, each aggregator, and nearby households stratified by contracting status, completed annual surveys, although stratification approaches varied by aggregator.

Due to these sampling differences, I focus on the contract farming scheme associated with a household sample that allows for the cleanest possible identification of the affects of entering into contract farming and potential spillovers to non-contracted households. This scheme was a contract farming arrangement to purchase maize from smallholder farmers in western central Mozambique. From 2017 to 2019, the aggregator expanded its contracting operation by nearly 50%. In Mozambique, maize is a staple crop grown by most rural households. It is rain-fed and harvested annually from March to June.

Within the sample studied at baseline, 99% of households grew maize and and 65% sold maize. These rates are typical for this region of Mozambique. Households grew between 2 and 3 crops on average and intercropping is common. Formal labor market opportunities are uncommon in the region. Less than 2% of households report participating in wage work. Most of households' labor is applied towards agricultural work, on the household's farm and

[2]For more details about MAAP see Appendix A

other farms in the area. Reciprocal labor arrangements are common. At baseline 41% of households reported using part-time labor but only two-thirds of And very few full time hires... Nearly all households have their own land (xOnly xThis limited use of land markets is also consistent with the relatively low population density of the region, ranging from one to 24 people per square kilometer (km) in the rural areas. The area were the contracting farmer scheme operates in around 150 km from Chimio, the fifth largest city in Mozambique. There is a main highway that runs north-south through the region and the households surveyed report living around 8 km away from the nearest paved road and around 4 km away from the nearest public transport. Nearly 75% of households have at least one cell phone.

The contracting firm selected which regions to contract within by determining which districts have the highest maize production and holding community meetings to gauge the interest levels of farmers in the region. The aggregator contracts with groups of farmers, as opposed to individuals, so the interested communities are approached and farmers determine amongst themselves who joins the contract group. As of July 2019, the aggregator was working with 159 farmer groups ranging in size from five to 25 farmers per group, with most groups on the larger side. The contract agreement between the aggregator and a farmer group is informal, verbal and not legally enforceable. Farmer groups can elect to obtain inputs on credit or purchase inputs such as seeds and fertilizer via the aggregator, but it is not required. The firm reports that most farmers do not choose to purchase fertilizer although many access improved seed through the firm. The aggregator also covers transportation costs and other fees in exchange for the farmer selling their maize to the aggregator and, when applicable, repaying any loans. The contract does not fix prices in advance but agrees to offer market prices plus a small premium. In the absence of contracting, farmers can sell there maize to traders the come to the farmgate or transport the maize to sell to traders or other buyers at roadside buying stations or markets.

In this context the main benefit of contract farming participation is a shift in the price distribution faced by farmers. With the contract guaranteeing at least market price, farmers no longer face the low end of the price distribution available through traditional marketing channels. For example, below market prices that might be offered by traders at the farmgate because of some market power or increased transportation costs, and contracted farmers no longer need to pay any search or transportation costs associated with the sale because it's covered by the contracting firm. The only price that would beat the contracted price is one far enough above the market average that it would remain above the market price net search and transportation costs. In short, the price distribution faced by contracted farmers has a higher mean and lower variance than the price distribution available via traditional marketing channels.

A main reason the firm participates in contract farming is secure the necessary inputs needed to meet downstream contracting obligations and to reach some minimum amount of throughput to cover the fixed costs of operating. While the firm does purchase maize on the spot market after harvest, contracting helps reduce the risk that the firm will not be able to obtain enough maize. There is competition within the spot market with an international exporter that mostly procures maize through traders as well as many traders or wholesalers trying to move maize to other domestic markets. Purchasing maize on the international spot market has high transaction costs, essentially limiting the producer to the domestic market. Mozambique technically allows for GMO maize to be imported with advanced approval from national authorities, but informational interviews with firms in Mozambique indicate that during the study period GMO maize could not be imported in practice. This effective ban on GMO maize limits firms ability to purchase maize on the world market. Although many African countries do not grow GMO maize, the firm cannot rely on the ability to purchase maize from neighboring countries either. Since maize is essential for food security so countries ban maize exports during hard agricultural years. For example, Zimbabwe, the nearest border to the contracting firm, banned the export of maize in 2019 when the region had a poor agricultural season. Even in the absence of importation challenges, the contracting firm would source maize domestically because downstream clients prefer local maize since the Mozambican government provides financial incentives for firms to use domestic inputs.

3 Conceptual and Theoretical Framework

Contract farming has been a topic of interest to economists for decades. Although much of the early literature on agricultural markets in low-income countries was theoretical, the contract farming literature has become nearly all empirical in the last two to three decades. These papers implicitly build upon risk aversion, transaction costs, contract theory, and others, but without an explicit common framework, systematically evaluating different empirical settings is a challenge. In this section, I present a model of contract farming that builds upon the conceptual framework presented in Barrett, Bachke, et al. 2012. For each stage of the process I present empirical regularities found in the literature and a model consistent with the patterns found in the literature and what is observed in the Mozambique maize CFA studied here.

The model highlights the non-random nature of contract farming participation and a channel for spillovers to non-contracted farmers via spot markets that has not yet been examined by the literature. Barrett, Bachke, et al. 2012 developed a four stage framework of CFA participation: i) firm choice of procurement location, ii) firm contract offer, iii) smallholder contract acceptance, and iv) firm and smallholder decisions to honor the contract. Each of these sequenced choices introduces selection effects that considerably complicate credible causal identification of the impacts of CFAs. The following theoretical framework explicitly models stages two, three, four, farmer production decisions, and firm spot market buying, i.e. purchasing goods that are received immediately as opposed to contracting to purchase and receive goods at a future date. The model generates several testable hypothesis that I take to the data in section 5.

Existing empirical literature focuses largely on identifying the welfare impacts of contract farming participation. Welfare is most often proxied for by household income, but many other indicators have been used. H. C. Michelson 2013 used household assets. Bellemare and Novak 2017 and Chege, Andersson, and Qaim 2015 used nutritional outcome. Some studies focus on agricultural incomes or profits (Narayanan 2014. Of the articles using household income as the outcome variable of interest, most find positive effects of contract farming on income. See Table 1 for a summary of welfare finding and see Ton et al. 2018 or Bellemare and Bloem 2018 for recent review articles. Given the endogenous selection into contract farming resulting from firm and farmer choices, isolating the causal impact of this is difficult. By modeling the contracting process, one can explicitly see how selection bias may enter the problem and identify which channels of income generation are affected directly and indirectly by participation in contract farming, as well as how living near contracting households may affect non-contracting households.

3.1 Stages 1 & 2: Firm procurement location and contract offer

In choosing where to locate, firms consider many factors, including physical infrastructure, agricultural and environmental conditions, economic and political conditions, and others. Several studies describe such a scenario (Miyata, Minot, and Hu 2009, Neven et al. 2009, H. C. Michelson 2013, Schipmann and Qaim 2010). The maize aggregator studied in this paper reaffirms the pattern of location selection. The firm reported selecting where to locate based on which districts had the highest levels of maize production. After selecting potential districts, the firm held community meetings to gauge the interest levels of farmers in different

Table 1: Empirical Regularities in the Contract Farming Literature

	Empirical Obs. Consistent with Model	**Empirical Obs. Omitted or Inconsistent with Model**
Stages 1 & 2: Firm procurement location and contract offer		
Contracting Selection by Buyer	- Based on agro-ecological qualities (Miyata, Minot, and Hu 2009, Schipmann and Qaim 2010, H. C. Michelson 2013) - Based on transportation conditions (Schipmann and Qaim 2010, H. C. Michelson 2013, Neven et al. 2009)	
Contract Traits	- Contracts organized via group (H. C. Michelson 2013, Bellemare and Novak 2017, Lentz and Upton 2016) - Prices higher and/or more stable than traditional market prices (H. Michelson, Reardon, and Perez 2012, H. C. Michelson 2013, Mujawamariya, D'Haese, and Speelman 2013, Miyata, Minot, and Hu 2009, Neven et al. 2009], Bellemare and Novak 2017, Bellemare, Lee, and Novak 2021, Bellemare 2012) - Buyer covers transport costs (Narayanan 2014, H. Michelson, Reardon, and Perez 2012, H. C. Michelson 2013)	- Buyer has quality standards (Narayanan 2014, Mujawamariya, D'Haese, and Speelman 2013, Abebe et al. 2013, Miyata, Minot, and Hu 2009, Minten, Randrianarison, and Swinnen 2007, H. Michelson, Reardon, and Perez 2012, H. C. Michelson 2013, Neven et al. 2009) - Buyer provides some inputs and technical support (Narayanan 2014, Miyata, Minot, and Hu 2009, Minten, Randrianarison, and Swinnen 2007, Bellemare 2012) - Contracts with individuals (H. C. Michelson 2013, Bellemare and Novak 2017, Neven et al. 2009, Bellemare 2012) - Seller covers transport costs (H. Michelson, Reardon, and Perez 2012, H. C. Michelson 2013, Neven et al. 2009) - Payment is delayed (H. Michelson, Reardon, and Perez 2012, H. C. Michelson 2013, Mujawamariya, D'Haese, and Speelman 2013, Neven et al. 2009, Lentz and Upton 2016) - Contracts are written (Bellemare 2012, H. Michelson, Reardon, and Perez 2012)
Product Traits	- Harvested annually (Mujawamariya, D'Haese, and Speelman 2013, Lentz and Upton 2016, Upton and Lentz 2017)	- Has no traditional market (Narayanan 2014, Schipmann and Qaim 2010) - Input intensive (Narayanan 2014, H. C. Michelson 2013, Abebe et al. 2013, Schipmann and Qaim 2010, Minten, Randrianarison, and Swinnen 2007, Neven et al. 2009) - Harvested multiple times per year (Narayanan 2014, H. Michelson, Reardon, and Perez 2012, Neven et al. 2009)
Stages 3 & 4: Firm procurement location and contract offer		
Contracting Farmer Differences	- More land (Miyata, Minot, and Hu 2009, Bellemare and Novak 2017, H. C. Michelson 2013, Rao and Qaim 2011, Bellemare, Lee, and Novak 2021, Bellemare 2012) - Wealthier (Bellemare 2018, H. C. Michelson 2013, Rao and Qaim 2011, Bellemare 2012)	- Men or male household heads (Mujawamariya, D'Haese, and Speelman 2013, Bellemare and Novak 2017) - More labor, household and/or hired (Mujawamariya, D'Haese, and Speelman 2013, Miyata, Minot, and Hu 2009, Bellemare and Novak 2017, Bellemare, Lee, and Novak 2021, Bellemare 2012)
		Continued on next page

Table 1 – continued from previous page

	Empirical Obs. Consistent with Model	**Empirical Obs. Omitted or Inconsistent with Model**
Default Risk	- Best predictor is gap between the market price and contracted price (Upton and Lentz 2017) - Past experiences with buyer lower risk (Upton and Lentz 2017)	- Sell to multiple buyers (Mujawamariya, D'Haese, and Speelman 2013, H. Michelson, Reardon, and Perez 2012) - Traditional markets accept lower quality (Mujawamariya, D'Haese, and Speelman 2013, H. Michelson, Reardon, and Perez 2012) - High rates of side selling (Lentz and Upton 2016, Upton and Lentz 2017)
Household Resource Reallocation	- Higher ag. income, net contracting income, and lower labor income (Bellemare 2018)	
Stages 5: Spot Market Purchases		
Spot Market Purchasing by Contracting Organization	- Mujawamariya, D'Haese, and Speelman 2013, Miyata, Minot, and Hu 2009, Upton and Lentz 2017	
Spillover Mechanisms		
Labor Markets		- Hire more labor (Meemken and Bellemare 2020, Neven et al. 2009, Rao and Qaim 2013) - Pay higher wages (Neven et al. 2009)
Spillovers, miscellaneous		- No robust spillover evidence, estimates large but imprecise (Meemken 2021) - Crop spread to domestic markets (Schipmann and Qaim 2010) - Better outcomes for non-contracted crops (Minten, Randrianarison, and Swinnen 2007, Bellemare 2018)
Welfare	- Net agricultural profits vary widely. Returns driven by higher yields, lower transaction costs (Narayanan 2014) - Higher incomes or income per capita (Meemken 2021, Miyata, Minot, and Hu 2009, Schipmann and Qaim 2010, Rao and Qaim 2011, Bellemare 2012, Bellemare 2018) - Lower income volatility (Bellemare, Lee, and Novak 2021) - Sold more contracted crop but no income differences (Lentz and Upton 2016)	- More assets (H. C. Michelson 2013) - Better nutritional outcomes (Bellemare and Novak 2017, Chege, Andersson, and Qaim 2015)

villages.

Given a firm's choice of location, the firm must then decide which farmers should be offered contracts and the terms of the contract. The firm makes these decisions, at least initially, under uncertainty and asymmetric information. The firm does not know what volume or quality of crops the farmers will produce nor whether farmers will honor the contract. Firms often attempt to reduce some output uncertainty through contracting terms like stipulating input use requirements and providing inputs on credit or through selecting farmers or groups to contract with based on observables that might be correlated with future output volume and quality. Firms can use similar methods minimize default risk, which is important because many CFA contracts are verbal and not easily enforceable legally or otherwise. To dissuade farmers from side-selling, aggregators can offer price premiums or at least prices more stable than traditional markets. Aggregators can contract for crops with no traditional market, thus eliminating the risk of side-selling completely. As with output, firm could select farmers based on observables that might predict default risk. Group contracts can also reduce default risk through risk pooling and peer selection effects. I'll discuss peer selection more in section 3.2.

In Table 1, I provide an overview of empirical commonalities about contracting terms, contracted product traits, and selection choices made by organizations about with whom and where to contract. There is a wide range of contract types found in the literature. In this model, I will consider a group contract over output quantity with fixed prices for a commodity with a large domestic market. For simplicity, I abstract away from output uncertainty and focus on the impact of asymmetric information on the firm's behavior. The key information asymmetry faced by the firm is a farmer's propensity to side-sell, the likelihood that a farmer will sell the contracted goods to another buyer.

Consider a unit mass of villages indexed by i. Villages are composed of two farmer types, type A which will always honor the contract and type B which only sometimes honor the contract. Ex-ante the firm does not know farmers' types and thus does not know how much output could be reliably purchased from each village. Each village is characterized by its distance from the firm, d_i, and its latent reliable agricultural output, ϕ_i, which is the agricultural output that will never be side-sold. This output term could comprise any fixed village characteristics that would influence productivity such as geographic conditions like soil type or altitude, in addition to the propensity for side-selling within a village which could depend on a village's distance to the nearest market in addition to the prevalence of farmer types. Prior to contracting, the firm knows all village distances, but only the average historical village output for the area, $\bar{\phi}$.

A firm chooses the villages in which it contracts so as to maximize profits. Let v_i be a binary variable that equals one if the firm contracts with a group of farmers in village i and zero otherwise. For each village the firm contracts within, the firm receives ϕ_i units of output from the contracted group of farmers. The total output the firm receives from contracted farmers in period t, y_t can then be expressed as

$$y_t = \sum_i \phi_i v_{i,t} \tag{1}$$

For each village in which the firm contracts, the firm incurs a variable cost which is proportional to the village's distance from the firm, cd_i. In the first period, the firm contracts within a village, $t = 1$, the firm incurs an entry cost, b, which can be thought of as the cost to build relationships or the one-off sunk cost required to learn a village's reliable output level. The firm is a price taker in the global market and receives net price p, the global price minus the contract price paid to farmers $p = p_W - p_C$, for each unit of output sold. In the first period when village specific side-selling risks are unknown, the firm maximizes *expected* profits by solving

$$\max_{\{v_{i,t=1}\}_i} \sum_i \left(p\bar{\phi} - cd_i - b\right) v_{i,t=1} \tag{2}$$

Solving this problem gives the following contracting condition

$$v*_{i,t=1} = \begin{cases} 1 & \text{if } d_i \leq \frac{p\bar{\phi}-b}{c} \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

The set of all villages that meet the contracting criteria of equation 3 is defined as contracting region V. This region includes all villages that are within the geographic region that generates non-negative *expected* profits. Due to information asymmetries, there will be some villages beyond the contracting region which would generate profits for the firm but will not be visited by the firm. For any village j such that $\phi_j > \bar{\phi}$ and $\frac{p\bar{\phi}-b}{c} < d_j \leq \frac{p\phi_j-b}{c}$, the firm is unwilling to risk entry under asymmetric information, but would enter under perfect information.

Once the contracting region is determined, the firm visits the villages within the region and offers a procurement contract to one group of farmers per village. The firm lets the farmers themselves select who is in the contracted group in order to overcome information asymmetry about farmer types, as I show in the following section. After the contracted crop is harvested, the group alerts the firm, and the firm returns to the village to collect the harvest and pay the farmers. The firm cannot guarantee above-market payment prices in advance but does offer a fixed price, p_C, in advance, which is on average higher than the market price at the time of procurement. As a result, the firm is not able to discourage side-selling by guaranteeing a higher price. Instead the firm discourages side-selling with a policy not to contract in any future periods with any group from which any group member side-sells. Since there is no output risk, once ϕ_i is learned, the firm expects to receive ϕ_i from the contracted group in village i in every period. The firm will know side-selling occurred in village i if it receives less than ϕ_i in any period $t \geq 2$.

After selecting the contracting region by solving equation 2, the firm will determine which groups to continue contracting with based on learned output levels and the application of the side-selling policy. The firm's contract farming profit maximization decision in $t > 1$ is

$$\max_{\{v_{i,t}\}_{i \in V, t>1}} \sum_{i \in V} (p\phi_i - cd_i)\, v_{i,t} \tag{4}$$

The differences between equation 2 and equation 4 are (i) that the firm no longer pays the one-off sunk cost, b, and (ii) that the firm knows ϕ_i for all $i \in V$. Thus the contracting region can be refined according to the following criteria:

$$v*_{i,t} = \begin{cases} 1 & \text{if } d_i \leq \frac{p\phi_{i,1}}{c},\ i \in V, \text{ and } \phi_{i,t} = \phi_{i,1} \forall\ t > 1 \\ 0 & \text{otherwise} \end{cases} \tag{5}$$

Equation 5 states that the firm continues contracting with groups in the contracting region that have realized non-negative profits, as opposed to *expected* profits as before, and which have not violated the no side-selling policy. The number of villages the firm works with in the contracting region could decrease between the $t = 1$ and $t > 1$ if there are groups such that $\phi_i < \bar{\phi} - \frac{b}{p}$. The larger the entry cost b, the more groups that will remain contracted in $t > 1$.

3.2 Stages 3 & 4: Smallholder contract acceptance and decision to honor contract

Once the firm has established its contracting region and determined whether farmers are interested in contracting with them, the farmers are instructed to form contracting groups.

Membership of the contracting group is finalized at the beginning of the agricultural season and thus known when farmers make decisions about agricultural inputs. The contract offered by the firm is a procurement contract. The firm cannot guarantee above-market prices in all periods but does offer a fixed price, p_C, in advance which is higher than the local market price, p_M, on average. When local market prices are greater than the contracted price, farmers face the temptation to side-sell and default on the contract. Table **??** presents empirical evidence on default, or side-selling, risks. Upton and Lentz 2017 finds for several East African countries and over several years that average default rate is 27% of the contracted output and that the best predictor of default was the difference between the contracted and local market price.

Local market prices follow a Bernoulli distribution[3]. With probability μ, the local price will be high, p_M^H, and with probability $1-\mu$, the local price will be low, p_M^L. This could be thought of as the probability of having a good or bad growing season. When farmers have a good season, there is relatively more supply which drives the local market price down, and the opposite occurs during a bad year. The firm, however, faces world prices through contracts with its buyers and thus can offer prices not affected by local market conditions. Contract prices and local market prices are such that $p_M^H > p_C > p_M^L$ and $p_C > \mathbb{E}(p_M)$[4]. Given the contract details and the local market outside option, participation in contract farming has two benefits for farmers: (i) higher sales prices on average, and (ii) eliminating the price risk faced when selling locally.

3.2.1 Smallholder contracting decisions

Each village contains a unit mass of farmers. There are two types of farmers. While the firm does not know the types of each farmer, farmers know each other's types which introduces the asymmetric information to the contracting problem that the firm resolves through group-based contract, much like lenders use group-based lending in micro-finance (Ghatak 1999, Ghatak 2000). Type A farmers care more about the future than type B farmers, with discount factors $0 \leq \beta^B < \beta^A \leq 1$.

[3] The relevant price for farmers is local market prices net transport costs which will vary across farmers. I implicitly set transport costs to market equal to zero here for all farmers.

[4] Contracting firms frequently offer above-market prices as a method to deter side-selling. Ton et al. (2018) find more than 50% of CFAs in their meta-analysis offer price premiums. Firms are also able to offer higher prices than local buyers because they are operating at scales unattainable to small buyers. This is particularly true for transportation costs. Another factor allowing firms to offer more stable prices is that many firms operating contract farming schemes have multiple product lines which enables firms to smooth input price risk across products.

Given that $p_C > \mathbb{E}(p_M)$, if, at the beginning of the planting season, farmers were offered to join a contracting group, all types would accept. When the low local market price is realized p_M^L, all farmer types will honor the contract and sell all of the contracted crop they produced that period, q, to the firm since $p_C > p_M^L$[5]. However, when the high local market price, p_M^H, is realized, only type A farmers will honor the contract; farmers of type B will choose to side-sell. Consider a farmer selling q units who, prior to contracting, chose to sell to a local trader. Let β^A be such that

$$u(p_C q_t) + \beta^A u(p_C q_t) \geq u(p_M^H q_t) + \beta^A u(\mathbb{E}(p_M) q_{t+1}). \tag{6}$$

This implies that for type A farmers the expected benefits from remaining contracted in future periods is greater than the current-period forgone income from honoring the contract

$$\beta^A[u(p_C q_{t+1}) - u(\mathbb{E}(p_M) q_{t+1}] > u(p_M^H q_t) - u(p_C q_t). \tag{7}$$

For type B farmers this is not true. Let $\beta^B < \beta^A$ be such that

$$u(p_C q_t) + \beta^B u(p_C q_{t+1}) < u(p_M^H q_t) + \beta^B u(\mathbb{E}(p_M) q_{t+1}). \tag{8}$$

Then, for these farmers the immediate income gain from side-selling in period t outweighs their expected benefits from remaining contracted in future periods. Given these preferences, type B farmers cannot be trusted to honor the contract farming agreement even though they would like to receive a contract at the beginning of the season. This carries the important implication that type A farmers will not join a contracting group if it contains any type B farmers due to the firm's default policy.

From section 3.1, the firm learns ϕ_i, the output amount the village is willing to sell to the firm, during the first period of the contract, and the firm must receive ϕ_i from the contracted group in village i in every period or it will discontinue contracting in village i. Let the unit mass of farmers in village i be indexed by j. Type A farmers can guarantee to supply quantity

$$\phi_i^A = \sum_{j \in i \& type=A} q_j \leq \phi_i^{both} = \sum_{j \in i} q_j \tag{9}$$

to the firm, where the inequality is strict as long as there are any type B farmers in village

[5]Recall that output is deterministic given a farmer's input choices. Adding a fixed level of the crop that farmers must hold back for their own use does not change the results presents in section 3.2.

i. If all farmers types join the contracting group, in the event that the high local market price is realized, all type B farmers will default and contracting will no longer be available to any farmers. Therefore, type A farmers are strictly better off excluding type B farmers and receiving the following utility

$$u(p_C q_t) + \sum_{s=t+1}^{\infty} \beta^{As} u(p_C q_s) > u(p_C q_t) + \mu \sum_{s=t+1}^{\infty} \beta^{As} u(\mathbb{E}(p_M) q_s) + (1-\mu)\beta^A \left[u(p_C q_t) + \sum_{s=t+2}^{\infty} \beta^{As} u(\mathbb{E}(p_M) q_s + ...) \right] \tag{10}$$

where μ is the probability type B farmers defaulting, equivalent to the probability of a high local market price occurring. Given this, the only contracting groups that form are groups comprised solely of type A farmers, and the firm observes $\phi_i = \phi_i^A$ as defined in equation 9. Type B farmers will be excluded from contract farming participation. This peer selection effect is analogous to that found in the microfinance group selection literature (Ghatak 1999, Ghatak 2000).

3.2.2 Smallholder agricultural production decisions

Farmers, having decided whether or not to join a contracting group, conditional on the firm offering one, choose which crops to produce and how much land and labor to allocate to the production of each crop. As highlighted in the previous section, contract farming can impact farmers incomes, and welfare, directly through prices, but there may also be indirect effects through the allocation of constrained resources. In this section, I present the utility maximization problem of a general household j, and then from the general forms of the optimal resource allocation conditions, I will discuss comparative statics between farmers of different types and contracting status.

3.2.2.1 General Farmer Utility Maximization

Note: Currently being adapted to include risk preferences and more general functional forms.
Farmer j has an endowment of land A_j and labor L_j. I assume away external land markets, which is consistent with the empirical setting evaluated in this paper. A farmer receives utility from the sum agricultural income they receive across all K crops a farmer could

plant and from leisure, and makes crop, land, and labor (and implicit leisure) decisions to maximize utility. Land allocation decisions for period t must be decided in period $t-1$ prior to knowing crop prices, growing season weather conditions, etc. Labor allocation decisions for period t are made in period t after any uncertainty is resolved. I assume that utility is additive across income and leisure and that farmers are risk neutral. Farmers all know and face the same price distributions and all have the same production technology. Farmers only differ according to endowments and discount factors, which will result in contracting status difference when contracting is offered. The utility maximization problem for farmer j in period t is

$$\max_{\{a_{k,t+1},l_{k,t}\}_k} \quad \sum_k p_{k,t}a_{k,t}^{\alpha}l_{k,t}^{\rho}+\delta(L_j-\sum_k l_{k,t})+\beta^j\left(\sum_k \mathbb{E}(p_{k,t+1})a_{k,t+1}^{\alpha}l_{k,t+1}^{\rho}+\delta(L_j-\sum_k l_{k,t+1})\right)$$

$$\text{s.t.} \quad \textstyle\sum_k a_{k,t+1} \leq A_j, \quad \sum_k l_{k,t} \leq L_j, \quad \text{a}_{k,t} \text{ given } \forall k \tag{11}$$

Examining first order conditions of the corresponding Lagrangian, the optimal allocation of next period land and current period labor to crop k must satisfy

$$p_{k,t}\rho p_{k,t}a_{k,t}^{\alpha}l_{k,t}^{\rho-1} = \delta + \lambda_1^j,$$

$$\beta^j\alpha\mathbb{E}(p_{k,t+1})a_{k,t+1}^{\alpha-1}l_{k,t+1}^{\rho} = \lambda_2^j$$

(12)

where λ_1 and λ_2 are the non-negative Lagrange multiplier associated with the labor and land constraints, respectively, and $0 \leq \alpha, \rho < 1$. With this utility function, the land use constraint will bind but the labor constraint may not. For the rest of the paper, I will consider only interior solutions for labor allocation, i.e. $\lambda_1 = 0$. By solving for the optimal labor allocations in terms of land allocations, we arrive at the following solutions for optimal labor and land allocations for crop k, respectively

$$\text{to update} \tag{13}$$

3.2.2.2 Comparative Statics

To add with testable hypotheses.

3.3 Stage 5: Firm Spot Market Decisions

In addition to purchasing crops through procurement contracts with farmer groups, the firm could purchase crops from non-contracted farmers within the contracting region on the post-harvest spot market. Transportation costs to reach farmers are high, and without a procurement contract, the firm cannot be sure that, once at the village, it would be able to buy enough to cover the transportation costs to and from the village. With forward contracting, the firm solves this problem. It knows it is profitable to enter the village to pick up the harvest from contracted farmers. Once the firm is in the village to collect harvested crops from the contracted farmers, the firm can also buy on the spot market directly in the village. Now the firm has already committed to paying the transportation costs to reach the contracted groups so it maximizes spot market buying in village i according to

$$\max_q pq \text{ s.t.} q_i + \phi_i \leq S \tag{14}$$

where p is the net price the firm receives as defined in section 3.1, q_i is the quantity purchased on the spot market in village i, ϕ_i is the quantity received from the contracted farmers, and S is the total load capacity of the truck(s) used to transport the goods back to the firm. Once in the village, a firm will purchase on the spot market up to the quantity that would fill the truck after collecting the contracted volume ϕ_i. Since contracted farmers have already sold to the firm, the farmers that the firm buys from on the village spot market are the non-contracted farmers. The firm's post-harvest spot market purchases create some positive spillovers for non-contracted farmers who reside within the contracting region. These non-contracted farmers would prefer to sell directly to the firm and receive the contracted price when it is higher than the local market price. In such cases where the contracting firm also purchases goods via local spot markets, contract farming can increase the incomes of non-contracted farmers. This spillover attenuates measured benefits from contract farming calculated by comparing contracted and non-contracted farmer incomes if such effects are not expressly controlled for in the research design.

3.4 Policy Intervention

Under uncertainty a firm deciding where and how many contracts to offer will operate in a smaller area and offer fewer contracts that it would under perfect information. If a public subsidy were given to firms to offset the entry costs firms must pay to learn about contracting region, b, firms would contract with the set of villages $V' = \{i|d_i \leq \frac{p\bar{\phi}}{c}\}$ in the initial period and maintain contracts with profitable villages in subsequent periods. This allows for more farmer groups to receive contracts, and remain contracted, than would be without such subsidy. How many more farmers receive contracts depends on the size of b and the distribution of village distances. *Note: to update with relevant spillover and welfare effects.*

4 Data and Empirical Framework

4.1 Data Collection

As part of MAAP, surveys were conducted annually with smallholder households in 2017, 2018, and 2019. This paper studies the household survey data. In addition to household surveys, aggregators participated in a formal annual survey coinciding with the household survey and were visited twice a year to collect operations data. Aggregator data is only used descriptively to provide context for the contract farming scheme.

The household survey included sections on demographics, household assets, labor decisions, household income sources, and agricultural decisions, such as crops grown, areas planted and inputs used. All currency data has been converted to 2017 Mozambique meticals (1 USD = 65 MZN) based on consumer price indexes reported for Chimio, the nearest city with inflation information. The baseline survey was conducted in November 2017, midline in July 2018, and endline in July 2019. Surveyed households were selected via stratified random sampling. Three survey samples were constructed: two from villages where the firm has a group contract, and one from a village where the firm does not have a group contract. Households from a total of six villages were surveys – five that gain a contracted group and one that does not receive the option to contract. Prior to the midline agricultural season, none of the sample villages (and by extension households within the village) had ever been given the option to create a contract group.

Within villages that were offered a contract, households from the contracted group were surveyed and households that were not members of the contracted group were surveyed, approximately 20 households from each category. In total around 115 households from each sample group were surveyed at baseline. I will refer to these groups as contracted households, non-contracted households from a village with a group, and non-contracted households from a village without a group throughout this paper. Over the three-year study, attrition between baseline and midline was approximately 12.9% and another 6.7% between midline and endline, bringing the full panel to 274 households. For more details about attrition see Appendix B.

Given that all sample groups are endogenously selected by the aggregator or farmers themselves, there are likely to be differences between these groups of farmers on observables and unobservables. Unobservables may be especially relevant when comparing contracted households to non-contracted household in villages with a contracting group because of the contract group peer selection process. Households will know more information about one another than is known by the researcher. Table 2 displays baseline summary statistics from all households. Households that began contracting at midline had larger households at baseline, were more likely male, owned more land, grew more maize, and were more likely to sell maize than both groups of non-contracting households.

4.2 Empirical Framework

I evaluate the effect of contracting status and contracting region on the following outcomes: i) prices received, amount sold, and income received from maize sales; ii) hired agricultural labor decisions; iii) household labor allocation decisions; iv) total household income. For each of the household-level outcome variables I estimate the following specification for household i in year t:

$$y_{it} = \beta_1 D_{it} + \beta_2 R_{it} + \gamma \mathbf{X}_i t + \alpha_t + \epsilon_{it} \tag{15}$$

where R indicates whether household i's village had any contracted farmers in year t, D is a dummy variable indicating whether household i has a contract in year t, $\mathbf{X}$ is a vector of household level controls, α_t is a year fixed effect, and ϵ is the i.i.d. error term. The coefficients of interest are β_2, the spillover effect for non-contracted households that live in villages

Table 2: Baseline Summary Statistics

	Contracted HHs		Non-contracted HHs inside Region		Non-contracted HHs outside Region			
	Mean	SD	Mean	SD	Mean	SD	F value	Pr(>F)
HH Size	6.36	2.68	5.52	2.24	4.82	2.69	8.49	0.00
% of HHs with Male Head	89.69	30.57	78.89	41.04	71.26	45.52	5.14	0.01
HH Head Age	41.06	13.95	39.74	15.51	41.09	15.73	0.24	0.79
% of HH Members Reporting Agriculture as Main Work	48.46	21.08	55.14	23.02	57.69	24.90	3.97	0.02
% of HH Members Reporting Any Agriculture Work	68.43	19.36	72.48	20.11	74.38	19.05	2.23	0.11
% of HHs Reporting Any Wage Work	1.30	5.03	1.25	4.50	1.17	4.81	0.02	0.98
% of HHs Reporting Any Self-Employed Work	4.17	9.22	3.96	13.10	5.87	14.57	0.63	0.53
TLU	1.85	4.74	1.51	3.55	1.22	3.80	0.55	0.58
HH Income in thousands(mt)	35.85	44.22	26.86	58.16	25.56	36.54	1.26	0.29
Total Land (ha)	3.97	2.63	2.78	2.32	3.07	3.02	4.28	0.02
Harvest Maize (tonne)	2.84	3.03	1.62	2.28	1.67	1.93	6.95	0.00
N	97		90		87			

with contracted households, and $\beta_1 + \beta_2$, the full effect of contract farming participation. There is a difference between households' contracting status as reported by the aggregator administrative data and as self-reported by the household in a few cases. As a result, both of these estimates are intent-to-treat effects. In Appendix C, for robustness I present the results using self-reported status.

Identification of the causal effect of being contracted, or living within the contracting region, relies on the parallel trend assumption; that in the absence of contracting, the contracted and non-contracted household would look the same. This assumption is commonly of concern in the empirical contract farming literature due to the non-random nature of selection. In order to control for this I include pre-contracting income and land-use levels in my set of household controls as well as household size and the gender of the household head.

5 Empirical Results and Discussion

Contract farming may affect households' income, and hence welfare, both directly through income received for the contracted crop, and indirectly through induced shifts in labor and land allocation, or spillovers to other crops through the use of inputs such as fertilizer (Minten, Randrianarison, and Swinnen 2007, Bellemare 2018). In addition to effects on the contracted households, there is also some question as to whether contracting generates spillover effects on non-contracted households (Meemken and Bellemare 2020, Neven et al. 2009, Rao and Qaim 2013, Schipmann and Qaim 2010). Most empirical research on this topic is based on cross-sectional, or in some case panel, data from contracted and non-contracted farmers in the same region. Without a "pure" control group, it is difficult to assess the size of such potential spillovers.

5.1 Direct Effects

As discussed in section 3, one approach firms take to reducing side-selling is by offering price premiums. Figures 1 and 2 present the CDF and PDF of per kilogram prices received by each sample group from baseline to endline. The distribution of prices received by contracted farmers has a higher mean and lower variance than that of both non-contracted groups. However, non-contracted households within the contracting region have higher mean prices than households outside the contracting region as well, although the variance remains similar. (STILL TO TEST FOR STOCHASTIC DOMINANCE) This effect results from spot market purchases the contracting firm makes from non-contracted farming near the contracted farmers.

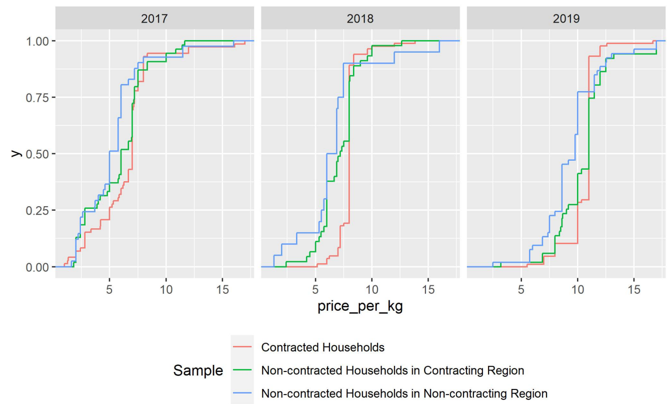

Figure 1: CDF of Maize Price per Kilogram

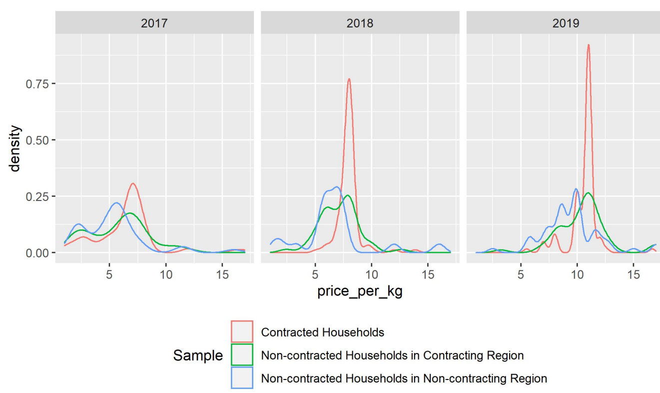

Figure 2: PDF of Maize Price per Kilogram

Table 3 affirms this. The price increase for maize is driven by households living within the contracting region as opposed to those being contracted themselves. Over the study period, the contracting region households received 0.881 meticals more than households outside the region, which is 11% of the average price. Columns 2 and 3 of the table present price effects split by year. In March 2019, Mozambique was hit by tropical cyclone Idai. Although the households in the study weren't directly affected by the cyclone, maize markets in Mozambique were. In addition to the natural destruction and crop loss putting upward pressure on prices, the World Food Programme entered the maize market in 2019 to purchase maize for food assistance programs further increasing pressure on prices. This is the type of scenario discussed in section 3 where market prices could exceed prices offered by the contracting firm leading farmers to default by side-selling to the local market, a scenario that contracting firms want to protect against, especially in a world with informal and legally unenforceable contracts. Column 3 shows that living inside the contracting region leads to receiving higher prices on average, while the contracting status coefficient becomes negative although insignificant. This suggests that contracted households may have forewent higher prices to honor the contract that non-contracted household could take advantage of. Column 2 likely reflects a more typical agricultural year and is consistent with the results the theory presented in section 3 predicted in a year when contracted prices are higher than market prices. The total effect of contracting is receiving prices 1.368 MZN higher on average than households outside of the contracting region. The effect for non-contracted households within the contracting region is smaller, at 0.751 MZN on average, because non-contracted households are not guaranteed the opportunity to sell to the contracting firm but are able to with some probability between 0 and 1, unlike households outside the contracting region.

Table 3: Regressions for Maize Sales

Dependent Var:	Price per Kg	Price per Kg, 2017 and 2018	Price per Kg, 2017 and 2019	Log Sold (kg)	Log Income from Maize Sales
contracting_status	0.155	0.617*	-0.287	0.345	0.055+
	(0.210)	(0.161)	(0.336)	(0.334)	(0.027)
contracting_region	0.881*	0.751*	1.101*	0.149	0.145**
	(0.269)	(0.209)	(0.366)	(0.384)	(0.036)
log_HH_income_bl	0.259	0.101	0.343	0.194+	0.037
	(0.169)	(0.301)	(0.202)	(0.076)	(0.027)
log_all_area_bl	0.046	0.111	-0.021	0.314+	0.002
	(0.130)	(0.258)	(0.262)	(0.145)	(0.028)
headsex	-0.251+	-0.019	-0.324	0.366	-0.008
	(0.121)	(0.228)	(0.181)	(0.253)	(0.028)
hhsize	0.011	0.074+	0.036	0.035	0.012+
	(0.037)	(0.031)	(0.055)	(0.028)	(0.005)
log_sold_kg					0.969***
					(0.022)
Num.Obs.	426	268	302	426	426
R2 Adj.	0.931	0.897	0.925	0.977	0.998

All models include year fixed effects. Standard errors are clustered at the village level.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Despite receiving higher prices, contracted households do not grow or sell (presented in column 4 of Table 3) more maize than non-contracted households inside or outside of the contracting region. But, conditional on the volume sold, contracted households earn more in income from maize sales than non-contracted households, and non-contracted households within the contracting region also earn more in maize sales than non-contracted households outside of the contracting region. The income effect from living within the contracting region is nearly three times the income effect from contracting.

5.2 Indirect Effects

5.2.1 Labor Allocation

As discussed in section 3 households may readjust their labor demand and labor supply after accepting a contract. Table 4 presents the extensive margin choice of hiring any part-time or full-time agricultural labor and the intensive margin for part-time labor measure by cost per hectacres. All coefficients of interested for contracting status and contracting region are insignificant, although some point estimates are large. While the likelihood of hiring labor did not change, the point estimates for part-time costs per hectacre suggest that households within the contracting region spend less on labor. This could be related to shifts in how household labor is allocated, as reported in Table 5.

Table 4: Regressions for Hired Labor

Dependent Var:	Hired PT Labor	PT Labor cost per ha	Hired FT Labor
contracting_status	0.062 (0.069)	108.934 (189.065)	-0.040 (0.029)
contracting_region	-0.008 (0.053)	-129.216 (70.702)	0.012 (0.029)
log_all_area_bl	0.047 (0.031)		0.064* (0.019)
log_HH_income_bl	0.089* (0.026)	253.184** (41.911)	0.017 (0.012)
headsex	0.011 (0.039)	190.180* (62.153)	-0.043 (0.028)
hhsize	0.005 (0.007)	-43.659* (14.379)	0.011 (0.006)
Num.Obs.	666	433	666
R2 Adj.	0.427	0.461	0.210

All models include year fixed effects. Standard errors are clustered at the village level.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Households participating in contract farming provide less wage labor and self employed labor, presumably moving that time into agricultural work on the family farm. However estimates of contracting status' and region's effects on the percent of household members who report agricultural as their main work or reporting doing any agricultural work are insignificant. Income earned from wage labor and self employment appears to fall for contracted households but neither estimate is statistically significant. Conversely, non-contracted households within the contracting region may provide more wage labor and self-employed labor and earn more income from those sources, as indicated by the positive point estimates, but none of the estimates are statistically significant. This is suggestive of the labor market spillovers discussed in section 3 but the evidence is not robust.

Table 5: Regressions for Household Labor

Dependent Var:	HH Wage Labor	% of HH in Wage Labor	Log Wage Income	HH Self Employed Labor	% of HH in Self Employed Labor	Log Self Employed Income	% of HH Reporting Any Ag Work	% of HH Reporting Main Ag Work
contracting_status	-0.046	-0.022+	-0.852	-0.192+	-0.036	-0.032	-0.008	-0.030
	(0.024)	(0.010)	(0.656)	(0.095)	(0.026)	(0.434)	(0.029)	(0.030)
contracting_region	0.039	0.015	0.562	0.089	0.024	0.033	0.025	-0.013
	(0.027)	(0.011)	(0.311)	(0.055)	(0.017)	(0.300)	(0.015)	(0.019)
log_all_area_bl	0.007	0.005	-0.626	-0.054	-0.010	-0.051	0.015	-0.011
	(0.005)	(0.007)	(0.641)	(0.042)	(0.016)	(0.168)	(0.020)	(0.013)
log_HH_income_bl	0.006	-0.005	0.773*	0.036	-0.002	0.318+	-0.016*	-0.043**
	(0.012)	(0.007)	(0.275)	(0.020)	(0.009)	(0.144)	(0.006)	(0.010)
headsex	0.055	0.022*	-0.261	0.060	0.020	0.715*	-0.009	0.033
	(0.035)	(0.007)	(0.348)	(0.030)	(0.014)	(0.273)	(0.018)	(0.027)
hhsize	0.004		-0.059	0.026*		0.058		
	(0.006)		(0.078)	(0.008)		(0.030)		
Num.Obs.	666	666	59	666	666	241	666	666
R2 Adj.	0.093	0.067	0.984	0.405	0.263	0.978	0.914	0.833

All models include year fixed effects. Standard errors are clustered at the village level.
+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

5.2.2 Household Income

For rational households to want to participate in contract farming, one expects that participation should make the household better off or at least not worse off. But if contract farming affects other sources of income for the household, and that is unaccounted for in the decision to join, the affect of contract farming becomes ambiguous. If contracted households reduce the amount of wage labor and self-employed labor they provide, the effect of contract farming on household income could be positive, null, or negative depending on the relative income gain from maize sales and loss from wage and self-employed income. Table 6 presents regression results for log household income and income per capita for the midline and endline year, controlling for baseline log household income. Columns 3 and 4 of Table 6 present the income results using only data from contracted and non-contracted households within the contracting region. In all cases the coefficients of interest are positive but not statistically significant. The point estimates suggest that, contracting and for non-contracted households, residing inside the contracting region has positive effects on income.

Table 6: Regressions for Household Income

Dependent Var:	Log HH income	Log HH income per capita	Log HH income, in Contracting Region	Log HH income per capita, in Contracting Region
contracting_status	0.197	0.171	0.230	0.189
	(0.160)	(0.149)	(0.162)	(0.145)
contracting_region	0.062	0.038		
	(0.151)	(0.151)		
log_all_area_bl	-0.033	-0.053	-0.107	-0.112
	(0.087)	(0.072)	(0.131)	(0.109)
log_HH_income_bl	0.233***	0.168**	0.242**	0.179*
	(0.032)	(0.033)	(0.045)	(0.041)
hhsize	0.119**		0.108*	
	(0.021)		(0.032)	
headsex	0.330	0.269	0.216	0.213
	(0.201)	(0.178)	(0.321)	(0.301)
Num.Obs.	443	443	301	301
R2 Adj.	0.991	0.987	0.992	0.988

All models include year fixed effects. Standard errors are clustered at the village level.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

6 Conclusion

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Appendices

A MAAP and Aggregator Details

In determining which firms to work with, a list of 45 potential aggregators was compiled. Given Let's Work and the World Bank Group's interest in sustainable, market-driven poverty reduction and the prevalence of aid-supported aggregating organizations, criteria were used to select business-oriented aggregators for the program. Aggregators were considered if: i) they were a for-profit company, NGO, or associations such as farmer cooperations; ii) they had been in operation for two or more years; iii) contract farming was an essential part of their business model; iv) they were commercially viable or would be soon. Eligible aggregators were encouraged to apply to participate in MAAP. Of the 45 previously identified firms, 14 submitted applications to MAAP. Very few of the remaining 31 firms met the selection criteria. During the selection process additional details, such as the involvement of women and youth or aggregator methods to discourage side-selling, i.e., defaulting on a contract by selling the goods to another buyer, were also considered. Aggregators that applied requested an amount of financial support for the expansion or intensification of their contract farming or "outgrower" system. From the firms that completed the application process, nine were selected. These firms covered a range of commodities including maize, cotton, sugar cane, baby corn, chilis, goats, and chickens[6]. Ultimately, MAAP worked with seven aggregators, because within the first year of MAAP, one of the selected firms had to withdraw due to an insurgency in the region, and another withdrew because of financial trouble.

The MAAP aggregator studied in this paper uses a contracting scheme to purchase maize from smallholder farmers. As part of MAAP, the aggregator expanded its contracting operation by nearly 50% from the 2016/2017 agricultural season. The agricultural season is defined by the main growing season for rain-fed crops such as maize, see Figure 3.

The contracting region was chosen by the firm, first by determining which districts have the best maize production, and then by holding community meetings to gauge the interest levels of farmers in the region. Figure 4 provides a map of the three categories of farmers surveyed. The first group are the households newly contracted by the firm for the 2017/2018 agricultural season. The second group of households surveyed were those within the contract-

[6]In Mozambique all tobacco is produced under contract farming schemes, but the World Bank Group does not provide support of any kind to tobacco production, processing, or marketing as a policy. Thus, no tobacco aggregators were considered for MAAP.

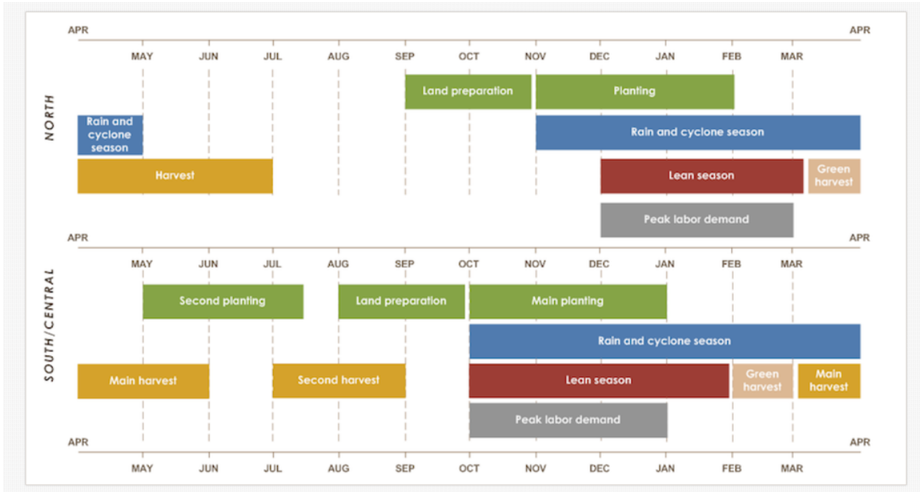

Figure 3: Mozambique Agricultural Seasons
Source: FEWS

ing region but that were not contracted. The final group surveyed were households outside of the contracting region. As seen in Figure 4 the contracting region is radiating outward and the households outside of the contracting region are just beyond that implied contracting boundary.

The contract agreement between the aggregator and farmers is informal and includes technical support through access to knowledge and inputs, optional lending support, and the funding of transportation costs and other fees in exchange for the farm selling their maize to the aggregator and, when applicable, repayment of loans. The aggregator coordinates with farmers through farmer groups, which are organized by the farmers themselves. If one member of a group borrows from the aggregator and does not repay the loan, the aggregator will cease to work with that group in future seasons. As of July 2019, the aggregator was working with 159 farmer groups ranging in size from five to 25 farmers per group.

The timing of support by the aggregator is as follows:

- In April and May, the aggregator hosts demonstration days. Three members from each farmer group attend to preview potential seeds, fertilizer, and other inputs they could order through the aggregator or technical support opportunities. The aggregator grows test plots using different inputs that the farmers can evaluate. The group members attending the demonstration days rotate so that different members of the group are able to benefit from the aggregator's technical support and relay the information to the

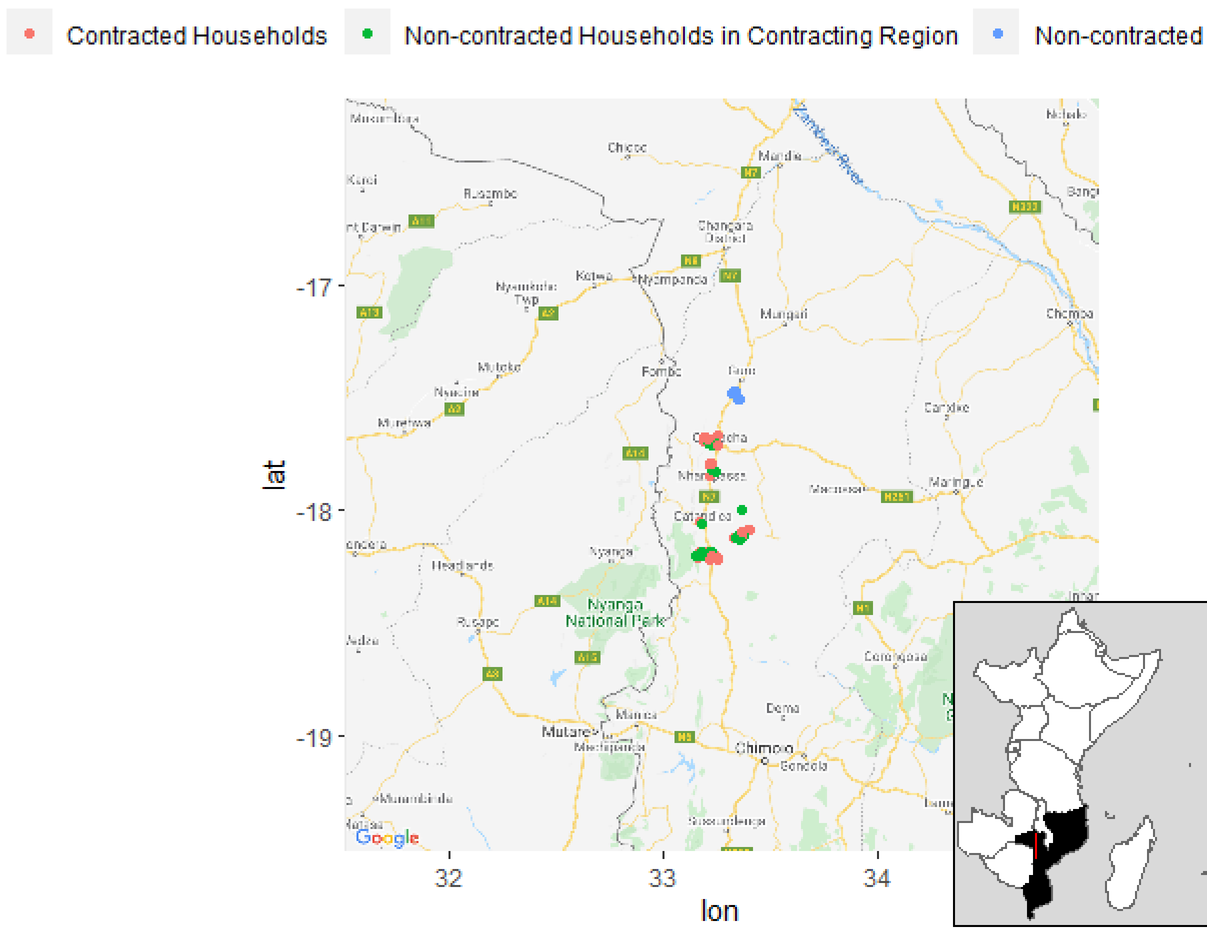

Figure 4: Geographic setting

rest of the group.

- In September, groups finalize their membership and select what inputs they want to order through the aggregator via cash or credit. Most farmers purchase inputs via cash. Sometimes farmers will start growing for the aggregator using credit and then transition to buying with cash after a few seasons.

- Inputs are then distributed by the aggregator to the farmer groups by the first part of November.

- During the growing season, farmers can reach out to the aggregator for technical support and the aggregator periodically makes field visits.

- At harvest, farmers call the aggregator when the maize is ready to be picked up and the aggregator will then meet in the field or at an aggregator-designated buying point. The aggregator had approximately 60 designated buying points as of July 2019. With these pick-ups the aggregator covers transportation costs and the cost of bags used to collect the maize. Farmers are paid in cash for the maize at the time of pick-up or drop-off if the maize was taken to a buying point. Farmers who received inputs on credit have that cost deducted from the payment for the maize. Some contracted farmers will then use the cash payment from the aggregator to purchase maize from non-contracted farmers in the area that they also sell to the aggregator.

Collecting maize directly from farmers in the field or at nearby buying points helps the aggregator minimize the likelihood of farmers side-selling. Additionally, the aggregator purchases maize on the spot market so non-contracted farmers can go to a buying point and sell to the aggregator

B Attrition

An F-test for significant differences between the sample group coefficients generates the following p-values, 0.1236 and 0.4652, for midline and endline attrition respectively. I will add the F-test stats to the table.

Table 7: Regressions for Attrition

	Midline Attrition	Endline Attrition
hhsize	-0.017+ (0.007)	-0.015** (0.002)
sample_group1	0.218* (0.072)	0.295** (0.044)
sample_group3	0.324* (0.104)	0.266** (0.048)
sample_group4	0.268* (0.069)	0.267*** (0.027)
area_all_land	0.003 (0.007)	0.004 (0.004)
headage	-0.002 (0.002)	-0.002* (0.001)
tlu	0.004 (0.004)	-0.001+ (0.001)
headsex	-0.011 (0.044)	-0.094* (0.030)
Num.Obs.	292	292
R2 Adj.	0.138	0.095

Standard errors are clustered at the village level.
+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

C Robustness: Self-Reported Contracting Status

I'll present the confusion matrix of admin vs self reported statuses and the rerun the regressions using the self reported status.