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Limitations of Contract Farming as a Pro-poor Strategy

The Case of Maize Outgrower Schemes in Upper West Ghana

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ABSTRACT

Contract farming (CF) arrangements have the potential to address market failures and improve technology adoption, productivity, and household welfare. Rigorous empirical evidence on their impact, however, is limited, and available studies show mixed results. In Ghana, the government and donors use CF as a strategy for developing and supporting agricultural value chains, yet to date, there have been no impact assessments of these CF schemes. This study is initiated to provide evidence on the profitability and likely impact of CF schemes, in order to inform the government and donors on what works and does not work.

The focus in this paper is on two relatively large maize-based CF schemes with fixed input packages (Masara and Akate) and a number of smaller and more flexible CF schemes in a remote region in Ghana (Upper West). Results show that these schemes led to improved technology adoption and yield increases. In addition, a subset of maize farmers with high yield improvements due to CF participation had high gross margins. However, on average, yields were not high enough to compensate for higher input requirements and cost of capital.

On average, households harvest 29–30 bags (100 kg each), or 2.9–3.0 metric tons, of maize per hectare, and the required repayment for fertilizer, seed, herbicide, and materials provided under the average CF scheme is 21–25 bags (50 kg each) per acre, or 2.6–3.0 tons per hectare, which leaves almost none for home consumption or for sale. Despite higher yields, the costs to produce 1 ton of maize under CF schemes remain high on average—higher than on maize farms without CF schemes, more than twice that of several countries in Africa, and more than seven times higher than that of major maize-exporting countries (the United States, Brazil, and Argentina). Sustainability of these CF schemes will depend on, from the firms' perspective, minimizing the costs to run and monitor them, and from the farmers' perspective, developing and promoting much-improved varieties and technologies that may lead to a jump in yields and gross margins to compensate for the high cost of credit.

Keywords: contract farming, value chain, technology adoption, productivity, profitability

JEL Codes: Q12, Q16, Q18, C36

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1. INTRODUCTION

Contract farming arrangements (CFAs) have become an increasingly popular institutional tool to ensure the quality and quantity of inputs or raw materials for processors, exporters, distributors, and supermarkets. Farmers enter into these CFAs to gain access to informal credit in the form of inputs and to assure a market for their harvests, especially in areas with market failures. CFAs are also said to help distribute risks between small farmers, traders, and agribusiness. There is considerable attention on CFAs in agricultural value chains, where quality concerns require greater coordination and where failures in output, input, and credit markets persist, especially in developing countries. These arrangements seem to be a win-win strategy for buyers and farmers.

However, the literature also shows instances in which this mutual benefit does not happen or when the agreement or mutual trust is broken, resulting in an increased risk of default by either party: (1) when farmers have an incentive to divert inputs to other uses or deviate from any of the stipulated arrangements, at the same time that the CFA's monitoring and enforcement is poor, leading to a moral hazard problem; (2) when buyers have strong bargaining power and thereby control the price of commodities and the terms of repayment of inputs provided on credit; (3) when there is low repayment or loan recovery due to side-selling, input diversion, or a dole-out mentality; and (4) when the commodity or available technologies or inputs being promoted through the CFA are simply not profitable enough to compensate for high transaction and operating costs, which lead to a high cost of credit (Deb and Suri 2013; Barrett et al. 2012; Oya 2012). Rigorous empirical evidence on the impact of CFAs is limited because most empirical studies struggle to establish causality (see discussions by Barrett et al. 2012; Bellemare et al. 2012; Miyata and Minot 2009; and Bolwig, Gibbon, and Jones 2009). Available studies show mixed results (Barrett et al. 2012; Abebe et al. 2013; Bellemare 2012; Miyata and Minot 2009; Wang et al. 2014; Reardon et al. 2009; Simmons, Winters, and Patrick 2005; Singh 2002; Warning and Key 2002; Oya 2012), and there is ongoing debate about CFAs' role in rural economic growth and poverty reduction (Barrett et al. 2012; Swinnen and Maertens 2007). A knowledge gap remains on the conditions in which CFAs can make an impact on incomes and welfare.

In Ghana, the government and its partners use CFAs as a strategy for developing and supporting agricultural value chains. Major agricultural programs such as the Block Farm Programme;[1] the Savannah Accelerated Development Authority (SADA); and the ADVANCE (Agricultural Development and Value Chain Enhancement) project, funded by the US Agency for International Development (USAID), promote and support these arrangements. There are also several private sector–led CFAs, and among the bigger and more popular ones is the Masara maize outgrower scheme, led by Yara Ghana, Wienco Ghana, and the Masara N'Arziki Farmers Association. Earlier reports indicated that CFAs—particularly the Block Farm Programme (Benin et al. 2013), USAID-ADVANCE (Kolavalli, Mensah-Bonsu, and Zaman 2015) and the Masara outgrower scheme (Guyver and MacCarthy 2011)—had made positive contributions to yields, incomes, and access to inputs. However, preliminary fieldwork for the present study has indicated a different story: the Masara outgrower scheme has pulled its operations out of Northern and Brong-Ahafo, the two largest maize-producing regions, and is now concentrating primarily on Upper West, leading to questions concerning its profitability and sustainability. To date, no impact assessment has been conducted on Masara and other CFAs in Ghana.

This paper looks particularly at various private sector–led maize outgrower schemes in the Upper West region of Ghana. It aims to contribute to the literature on several fronts. First, focusing on maize makes an interesting case to study CFAs. Literature has predicted that CFAs, collective action, and other

[1] This program started in 2009 with pilots in six regions (Ashanti, Brong-Ahafo, Central, Northern, Upper East, and Upper West), with the aim of improving agriculture and farming as a business by targeting large tracts of arable land (in blocks) in different locations for the production of selected commodities in which the areas have comparative advantage. Designed to focus on youth, the Block Farm Programme brings several beneficiaries together in one large production area and provides them with extension services and credit in the form of mechanization services, certified seed, subsidized fertilizer, and pesticides, and in return, it is expected that the credit will be paid back in crops at the time of harvest (Benin et al. 2013).

institutional arrangements would not likely work for traditional, staple, and nondifferentiated commodities because spot markets would be the most efficient system (see World Bank 2014; Berdegué 2002; and Hellin, Lundy, and Meijer 2007). Transaction costs associated with market access are relatively low: there are so many buyers and sellers that contract farming (CF) or collective action would have little impact on, say, maize prices; in addition, the likelihood of side-selling can be high. Nevertheless, input and output market uncertainties and unavailability of inputs at crucial times are serious issues in many undeveloped and remote areas, including many districts in Ghana. Abebe and colleagues (2013), using discrete choice modeling, showed incentives for farmers to engage in CFAs and farmers' preferences in terms of specific contract design attributes. The authors illustrated that for potato farmers in Ethiopia, input market uncertainty was more important than output market uncertainty as an incentive for CFA participation.

Maize is traditionally a nondifferentiated staple crop, unlike the high-value commodities that are the focus of recent literature on CFAs, but at the same time it is highly commercial: maize-producing households in Ghana sell 60 percent of their harvest on average (Ragasa et al. 2013). Maize is used in food processing, breweries, and poultry farms; and maize demanded by these sectors is growing due to greater industrialization and urbanization in Ghana (Ragasa, Chapoto, and Kolavalli 2014; Andam et al. 2015, 2016). Greater certainty in quantity and quality (mostly in terms of dryness and color) is therefore increasingly needed in maize value chains.

Several informal outgrower schemes in maize, led by aggregators or traders, have been operating for several years in Ghana. Recent development projects (such as ADVANCE and SADA) had aimed to build on and provide assistance to these informal, private sector–led schemes. New and bigger outgrower schemes have also recently entered the arena: (1) the Masara outgrower scheme, mainly aimed at buying maize in bulk at low prices and at the same time promoting branded inputs (Yara Actyva[2] fertilizer and Pannar 12 and Pannar 53 seeds from Wienco); and (2) the Akate CF program, mainly aiming to ensure the maize input supply for the Akate poultry farm. Both of these outgrower schemes are home-grown and have been running for about six years without government or donor assistance, which leads to the hypothesis that they may be working well and sustainably. Focusing on maize (a staple yet highly commercial crop in Ghana), then, may provide insights on the extent to which maize is becoming a more highly valued commodity that requires greater coordination in the market, rather than reliance on the spot market. Such a focus may also reveal whether it is the highly inefficient output, input, and credit markets that are making CFAs continue to play a role in the maize value chain. It may help pinpoint what market failures CFAs address. This paper aims to provide insights as to whether CFAs have a role in a highly commercial but not high-value crop such as maize and to clarify under what conditions CFAs can contribute to value chain development and farmers' welfare.

A second contribution of this paper is that it looks at various schemes operating in a particular commodity and region of a country, whereas existing literature looks at only one particular scheme. Because there may be significant differences and lessons to be learned, disaggregating and comparing across schemes may be a valuable exercise. For instance, the Masara and Akate schemes are similar, and their impacts and the magnitude of these impacts are also very similar; however, the factors that predict both farmers' participation and their achievement of higher yields and profits seem to differ across the two schemes. Moreover, other schemes that are smaller and more flexible tend to have less impact on technology adoption and yield, but at the same time have smaller required repayments or less costly credit, resulting in a net effect on profit similar to that of the Masara and Akate schemes.

Third, the current paper attempts to measure the impact of CF beyond the commonly used measure of the gross margins of farms under the scheme. Our exploratory fieldwork reveals a tendency of contract farmers to divert CFA inputs for use on their nonscheme plots or for sale to other farmers. If this diversion is not accounted for, the impacts of the CFA may be underestimated. Our unique dataset, at plot level and covering both scheme and nonscheme plots and their changes for two periods, can address these

[2] N23 P10 K5 3S 2MgO 0.3Zn, compared with other popular fertilizer types in Ghana such as NPK 15-15-15 or sulfate of ammonia (nitrogen 21 percent, sulfur 24 percent).

concerns. Our results show an underestimation of the magnitude of the CFA's impacts. While the underestimation is small and does not change our main findings, it shows that more farmers than initially estimated would have actually profited and benefited from CFAs.

Fourth, this paper looks at heterogeneous impacts depending on farm, farmer, and location characteristics by using disaggregated and restricted models. It looks at the diversity of outcomes (in terms of yields and incomes) within the scheme and helps identify factors that explain heterogeneity in outcomes within and across schemes. It also looks at within-household variation—that is, it compares the scheme and nonscheme maize plots of the same household. Finally, it simulates possible scenarios in which the productivity and profitability of CFAs can be improved.

This paper provides evidence that maize outgrower schemes in the Upper West region of Ghana have a significant positive effect on adoption of improved varieties, particularly hybrid maize and certified seed, fertilizer, herbicide, tractor services, and improved management practices. As a result, the schemes have a positive effect on yield improvements. A subset of farmers with high yield increases due to CF participation have high gross margins. However, on average, yields are not high enough to compensate for the higher input requirements and the cost of capital (that is, the very high interest rate charged for the inputs provided up front). On average, nonscheme plots have lower yields but much higher profits than scheme plots. Various estimation models show the negative impact of CFAs on maize profitability on average. Despite obvious benefits to some maize farmers, this result indicates the limitations of CF as a broad-based pro-poor strategy in a context similar to Upper West, Ghana. Reducing scheme operating costs, lowering the required repayments, and more importantly, promoting higher-yield varieties and improved technologies will likely enable a greater number of maize producers to benefit from CFAs.

The rest of the paper is structured as follows. Section 2 describes the different CF schemes analyzed in the paper. Section 3 presents data sources and methods. Section 4 discusses the main results. Section 5 summarizes the findings and outlines the implications for policy and further research.

2. MAIZE CONTRACT FARMING SCHEMES

The Masara Contract Farming Scheme

The most prominent and well-known CF scheme in the Northern region of Ghana is organized by the Masara N'Arziki Farmers Association and is generally referred to as "Masara." Masara was created in 2009 by two major private agribusiness firms, Wienco and Yara (Amanor 2011). It is registered as a nonprofit organization with the overall objective to use maize growing as a source of prosperity (Guyver and MacCarthy 2011). However, it is essentially set up as a CF scheme, and association membership is possible only through CF participation. Masara strives to be self-sustaining in terms of funding and is considering turning itself into a profitable enterprise and possibly changing its status from a nonprofit to a for-profit association (Prorustica 2013; personal communication with Masara management and field staff, 06 23, 2016).

Farmers who participate in the Masara association engage in a written contract with Masara. They receive a fixed package of quality inputs and extension services but must pay back a specified number of bags of maize at harvest. The exact amount to pay back is calculated based on the principle that farmers return the value of the inputs they have received. Masara provides an opportunity for the founding agribusiness firms to disseminate agricultural inputs. The input package consists of Actyva fertilizer from Yara and herbicides and maize seeds from Wienco.

Originally, farmers had to sign up in joint liability groups of 5–10 farmers. Farmers were encouraged to cultivate on plots located close together. If one farmer in the group did not pay during harvest season, the other group members were equally excluded from the program (Prorustica 2013). Yet individual farmers with sufficient land and creditworthiness were also accepted into the scheme.

Most packages contain imported hybrid maize seed, Pannar 53 or Pannar 12. Farmers can request a less expensive package with Obatanpa seed rather than Pannar seed, but such requests are rare. Obatanpa, an open-pollinated maize variety, was released in Ghana in 1992 and is currently the dominant maize variety (Ragasa et al. 2013). Overall, it is estimated that Pannar varieties yield from 15 to 60 percent higher and are on average 18 to 90 percent more profitable than the Obatanpa, although they require greater use of fertilizer (Ragasa et al. 2013; Tripp and Ragasa 2015; IPA, IFPRI, and SARI 2016).

For several years, CF participation was the only means for smallholder farmers to acquire Pannar seeds in Ghana. Wienco sold some of the seed to larger farmers, local CF schemes, and government programs, providing only a small amount to seed dealers (Tripp and Ragasa 2015). Only in 2015 was Pannar 53 officially released in Ghana, and the release of Pannar 12 is still pending at the time of this writing (Tripp and Ragasa 2015).

Over time, Masara has made several adjustments in order to reduce problems of default and scheme exit. Despite a very low default rate of less than 4 percent in 2015 (personal communication with Masara management, 06 23, 2016), scheme exit was high. According to Masara management, the default of one member of a given group could lead to a high overall exit rate. In 2015, Masara therefore abandoned the approach of joint liability groups. Moreover, new entrants were offered a package with Obatanpa rather than the more expensive Pannar. Only if they succeeded in fulfilling the repayment requirements would they be allowed to get the more expensive package with Pannar in the following year. Finally, at harvest time, farmers now have to make a deposit of 10 percent of the repayment requirement on the input package for the following season. In principle, farmers are also required to sell their excess produce to Masara. In practice, this is rarely done and is not strictly enforced (personal communication with Masara management and field staff, 06 23, 2016).

The Masara CF scheme started with 1,250 farmers in 2009 and had grown to about 10,000 by 2015 (personal communication with Masara management, 06 23, 2016). Over that period, Masara expanded operations to new districts and regions but also stopped its operations in other areas. Activities in the Brong-Ahafo region and around Tamale, the capital of the Northern region, have been reduced to a few hundred acres. In these regions especially, the scheme encountered challenges to repayment and continued participation.

Akate Farms

Aside from Masara scheme, there are also a number of home-grown CF schemes for maize in Upper West, set up by local farmers or maize aggregators. At least 10 different local CF schemes were identified in the Upper West region during preparatory qualitative fieldwork. The most active aggregator in our case study area is Akate Farms.

Akate Farms started its CF activities in 2011 with 156 farmers and rapidly expanded to 695 farmers in 2015. Its primary objective is to assure a consistent supply of quality maize to produce feed for its poultry farm. The Akate CF scheme operates very similarly to the Masara scheme. CF participants sign a written contract and receive a fixed input package consisting of fertilizer, Pannar 12 or Pannar 53 hybrid maize seeds, and herbicides. But there is some flexibility if participants do not want this comprehensive package, and the required repayment is adjusted accordingly. At times, when Pannar 12 or Pannar 53 seeds were not easily available on time, the scheme has used Obatanpa for its outgrowers. Moreover, upon request, Akate Farms can also provide tractor services. For farmer training and extension advice, Akate collaborates with extension officers from the Ministry of Food and Agriculture.

The amount of harvested maize requested to pay for the inputs is also similar to the Masara repayment, with additional payment required for the tractor services. Unlike Masara, Akate outgrowers are not required to sell all output to Akate. So, although similar in many ways, the Akate scheme is different from the Masara scheme in terms of fertilizer type, some flexibility in the seed variety and input package, the offer of tractor services, and the absence of a requirement to sell all produce to the firm. These design features may affect farmers' decision to participate and to continue, and they may also influence the yield and profitability differently between Akate and Masara.

Other Contract Farming Schemes

Other CF schemes range in size from 25 to 700 participating farmers. Larger schemes and those that provide more inputs typically engage in written contracts, whereas smaller schemes with smaller input packages often rely on verbal agreements. The smaller CF schemes do not provide hybrid maize seeds and generally have more flexible input packages. These CF schemes are often operated by aggregators, whose main business is aggregation of maize and other crops, although they are also farmers themselves and they usually help demonstrate and promote improved management practices, with or without assistance projects. During our fieldwork, aggregators mentioned that the inputs provided on credit in these smaller CF schemes are based on what farmers need and request. The required repayment is much lower and closer to market prices than that of Masara and Akate. Farmers are generally not required to sell all of their harvest to the aggregator. The repayments are also more flexible—that is, aggregators accept any crop harvest or in-kind payment, especially if it is one of the commodities being aggregated or traded by the aggregators.

Aggregators explained that the main motivation to organize a CF scheme is to have a more consistent supply of maize, access to good-quality maize, and reduced search costs and haggling over prices on the spot market. Some of the CF schemes in the focus districts have recently received support from donor projects (mainly USAID's ADVANCE project) or the government (as part of the SADA program) in the form of capacity-building activities, training on agricultural and farm business practices, and provision or cofinancing of some supplies and equipment.

Table 2.1 shows a brief description of the different schemes, in which we got information on, including the inputs provided, required repayments, and reported prices.

Table 2.1 Comparison of various maize-based CF schemes in Upper West region, Ghana

Scheme	Masara		Akate	Mashood Dori	James Wobil	Yahaya Seidu	Issifu Yommie	John Dimah	Kedan	General comments and observations
Districts	Sissala East, Sissala West, Wa East and others outside the study area		Sissala East, Sissala West, Wa East	Wa East	Sissala East	Sissala west	Sissala West	Sissala west	Sissala East	
Written or verbal contract	written		written	written	verbal	verbal	verbal	written	written	
Number of outgrowers	10,000		695	700	25	35	110	336	125	
Year of start	2009		2010	2005	2013	2014	2012	2008	2012	
Inputs provided	Starter package (seeds (Obatanpa), fertilizer, herbicides)	More expensive package (seeds (Pannar), fertilizer, herbicides)	Seeds (Pannar), fertilizer, herbicides, tractor services	seeds, fertilizer, herbicides, tractor services	Seeds (Obatanpa or Abontem), fertilizer, herbicides, tractor services	fertilizer	fertilizer, tractor services	seeds (Pannar), fertilizer, tractor services	seeds, fertilizer, herbicides, tractor services	
Required repayments in maize grains (50-kg bag per acre)	18	20-22	21	16	20-22	4	8	17	14	
<u>Cost of inputs provided (as reported by the scheme operators) (GHS per acre) (details of the quantity and unit price in parentheses)</u>										
Seed	50 (10 kg @ GHS 5/kg)	180 (10 kg @ GHS 18/kg)	162 (9 kg @ GHS 18/kg)	45 (9 kg @ GHs 5/kg) for Etubi or Mamaba; 36 (9 kg @ GHS 4/kg) for Obatanpa	50 (10 kg @ GHS 5/kg)			180 (10 kg @ GHS 18/kg)	45 (9 kg @ GHS 5/acre)	generally similar prices

Table 2.1 Continued

Scheme	Masara		Akate	Mashood Dori	James Wobil	Yahaya Seidu	Issifu Yommie	John Dimah	Kedan	General comments and observations
Fertilizer	480 (4 bags @ GHS 120/bag)	600 (5 bags @ GHS 120/bag)	525 (5 bags @ GHS 125/bag)	280 (2 bags of NPK @ GHS 200/bag and 1 bag of SOA @ GHS 80/bag)	480 (4 bags @ GHS 120/bag)	120 (1 bag @ GHS 120/bag)	300 (3 bags @ GHS 100/bag)	480 (4 bags of Actyva @ GHS 120/bag); 360 (4 bags of Chemico @ GHS 90/bag)	230 (2 bags @ GHS 115/bag)	Different unit price of fertilizer given, ranging from GHS 80-125/bag. IFPRI/ISSER (2016) show that overwhelming majority of respondents reported GHS 80-100 as fertilizer price (regardless of type (SOA, NPK, Actyva)), and the mean and median is GHS 90/bag
Herbicide	100 (2 bottles @ GHS 50/bottle)	100 (2 bottles @ GHS 50/bottle)	79 (2 bottles @ GHS 39.50/bottle)	100 (2 bottles @ GHS 50/bottle)	100 (2 bottles @ GHS 50/bottle)				45 (1 bottle @ GHS 45/bottle)	generally similar prices
Tractor services			70	80	75		65	70	70	some differences, cost per acre ranges from GHS 65 to GHS 80 cedi to a 100-bag of maize grain.
Cost of inputs based on calculations by scheme operators	630	880	840	496	705	120	365	730	390	this is computed based on the input prices/costs provided by scheme operators
Required repayment in cedi/acre (using the input and maize prices as given by schemes)	576	672	880	800	945	180	400	680	560	different prices of maize grain used by different schemes in computing their costs and repayments

Table 2.1 Continued

Scheme	Masara		Akate	Mashood Dori	James Wobil	Yahaya Seidu	Issifu Yommie	John Dimah	Kedan	General comments and observations
Maize prices reported by scheme operators that are used in the computations above (in GHS/50-kg bag)	*In 2015, GHS 29.50/bag was the agreed price by the council; GHS 34.50/bag was paid after recovery.*	*In 2015, GHS 29.50/bag was the agreed price by the council; GHS 34.50/bag, after recovery.*	*In 2015, GHS 40/bag for yellow and GHS 35/bag for white, and GHS 45/bag of yellow or white maize, after repayment.*	*50*	*90 (80 for white; 100 for yellow maize)*	*45*	*50*	*40*	*40*	*very different maize prices reported by scheme operators they used in paying outgrowers*
Difference in requirement repayment and costs (%) /1 based on scheme operators' reported costs and prices	-9	-24	5	61	34	50	10	-7	44	very different interest rates, with average of 18% after six months
What if average market prices of fertilizer and maize grain are used? (in GHS/acre)										
Total cost of inputs using average market prices for fertilizer (GHS 90/50-kg bag)	510	730	765	486	625	90	335	610	340	this is computed based on the average market prices of fertilizer (GHS 90/50-kg bag)
Required repayment in cedi/acre (using average maize grain prices of GHS 90/100-kg bag)	810	945	990	720	945	180	360	765	630	this is computed based on the average market prices of maize grain (GHS 90/100-kg bag)
Difference in Interest rate after 6 months (%) /1 using average market prices	59	29	29	48	51	100	7	25	85	very different interest rates, with average of 48% after six months

Source: Raw data is taken from various in-depth interviews with scheme operators and aggregators conducted by IFPRI in August and December 2016; IFPRI and ISSER survey (2016).

Note: Exchange rate in 2015 was GHS 4.00 = USD 1; /1 This can also be interpreted as the nominal interest rate of borrowing inputs from the scheme and to be repaid after 5 to 6 months.

3. DATA AND METHODS

Modeling Farmers' Decision to Participate in a Contract Farming Scheme

We model farmers' participation in a particular CF scheme in a random utility framework. Utility, *U*, is determined by a set of farm, household, and community variables, *X*, which also influence the farmers' ability and willingness to participate in a scheme. The farmer is assumed to maximize utility:

$$MAX\ U = f(X). \tag{1}$$

We postulate that maize farmer *i* will participate in scheme *j* at time *t* if the expected utility derived from participating, U_{ijt}, is greater than the expected utility, U_{imt}, of not participating, *m*. The latter utility can also change over time, *t*. Moreover, *j* can be any scheme, and farmer *i* can also choose among these schemes. In addition, farmer *i* can also choose which crop or plot, *k*, to cultivate with or without a CF scheme, and what scheme. This net utility is represented by

$$U^* = U_{ijt} > U_{imt}, \tag{2}$$

where *U** represents the benefits of participating in scheme *j* as opposed to not participating, *m*. While *U** itself is unobserved, we can observe the scheme that the farmer participates in as his or her revealed preference. The probability that farmer *i* participates in scheme *j* for plot *k* can be denoted by $Pr(I = 1)$. If the farmer does not participate in CF scheme *j*, *U** takes a value of 0.

If we assume a linear relationship, *U** can be written as

$$U_{ijkt} = \beta_{jt} X_{ikt} + u_{ijkt}, \tag{3}$$

where β_{jt} is a vector of coefficients to be estimated and *u* is a vector of random disturbances of the unobserved factors affecting the participation decision. In a smallholder environment with widespread market imperfections, utility maximization may differ from profit maximization. Hence, the variables included in *X* should cover a broad set of socioeconomic variables that also capture individual market access conditions, connectivity, incentives, ability, and risk preferences. We analyze farmers' decision to participate in three different schemes (Masara, Akate, and other schemes taken in aggregate), each with a different firm leader, different input provision and required repayment, and varying terms and processes and therefore different expected benefits. Hence, the factors that influence participation in each scheme may differ as well. As discussed, Masara provides a fixed set of inputs; Akate offers some flexibility as to seeds and other inputs, although in recent years it has more closely mimicked Masara's input package; and other schemes, because they are smaller and less formal, are more flexible in terms of the type and quantity of inputs provided and the associated repayment schedule. The flexibility of the latter may attract more participants and benefit them more, but the fixed packages offered by Masara can assure participants of greater quantities of fertilizer and hybrid seeds.

Outcome Variables

We aim to measure the impact of CF schemes on technology adoption, productivity, and profitability. The main inputs and technologies promoted for maize are chemical fertilizer use, improved varieties, certified seed use every year, and proper planting and spacing (row planting, dibbling, using one seed per hole, and proper spacing) (Ragasa et al. 2013). Fertilizer use is measured in terms of nitrogen amount used, and the other variables are measured as binary responses. We measure yield using an index developed by Liu and Myers (2009) to adjust for intercropping, and we measure profitability as value of production less total cost, excluding family and communal labor.

Modeling the Impact of Contract Farming Schemes

In theory, the impact of a program, project, or scheme should be evaluated by estimating the average treatment effect on the treated (ATT),

$$E(W_i|I=1) = E(Y_{i1}|I=1) - E(Y_{i0}|I=1), \quad (4)$$

where W_i denotes the unbiased welfare effect for households *i* that participate in the scheme. Y_{i1} is the outcome variable of interest (for example, technology adoption, yield, or profit) with the CF scheme, and Y_{i0} is the outcome variable if the same households were not participating in CF. Unfortunately, the same households are not observed with changes in their welfare both with and without CF participation over time, so in reality one has to compare between CF and non-CF plots within the same household and between CF and non-CF households that are not identical:

$$E(W_i|I = 1 = E(Y_{i1}|I=1) - E(Y_{i0}|I=0), \quad (5)$$

where $(Y_{i0}|I=1)$ is the outcome for households not participating in scheme or plots not under scheme. Equations (4) and (5) lead to identical results when there is no systematic difference between participating and nonparticipating households, except for the CF scheme participation itself. Yet whenever participating and nonparticipating households differ in terms of observed or unobserved characteristics, equation (5) will lead to biased impact estimates, where *Bias* can be represented as

$$Bias = E(Y_{i0}|I=1) - E(Y_{i0}|I=0). \quad (6)$$

A good method to avoid estimation bias is to run an experiment in which households are randomly assigned to treatment and control groups, thus ensuring that there are no systematic differences. In our case, however, the firms leading the CF schemes are not willing to perform such random assignment. Therefore our study builds on observational data in a context in which households self-select into the CF scheme. We use several techniques to minimize selection bias when evaluating the impact of different CF schemes. Among them are matching techniques to limit data to comparable groups, as well as instrumental variables (IV) regression with a control function approach to control for unobserved heterogeneity of the data. These techniques show consistent results on the significance of the impact of different CF schemes.

Techniques to Address Selection Bias

The first technique used is a matching approach. We use generalized propensity scores to control for pretreatment differences between with- and without-scheme households in estimating the ATT. Propensity score matching (PSM) is often used to evaluate the impacts of a binary treatment variable (for example, Fischer and Qaim 2012; Ruben and Fort 2012). However, in our case there are three different CF schemes, j, that farmers can participate in, so the treatment variable can take more than two possible values. In particular, with three CF schemes and one control group, the treatment variable can have four possible values. The analysis takes place at the plot level because a given household can have both with-scheme and without-scheme maize plots. We define $j = 0$ for plots that are not under any scheme, $j = 1$ for plots under the Masara scheme, $j = 2$ for plots under the Akate scheme, and $j = 3$ for plots under another scheme. We follow theoretical foundations by Imbens (2000) and empirical applications by Gerfin and Lechner (2002) and Lechner (2002) for estimating propensity scores with multiple treatments. For each CF scheme, we predict the individual probability of participation using an unconditional multinomial probit model. Appendix Table A.1 shows the results of estimating the multinomial probit model. The observables used in the models are those candidate covariates that might confound the relationship between treatment and outcome. Theoretically speaking, these observables should likely explain both treatment and outcome. Predicted propensity scores of participation can be written as

$$\hat{P}_j(x), j\epsilon J = \{0, 1, \ldots 3\}. \quad (7)$$

Following Lechner (2002), the resulting pairwise propensity scores are

$$\hat{P}_{j/mj}(x) = \frac{\hat{P}_j(x)}{\hat{P}_j(x)+\hat{P}_m(x)} \ \forall m \neq j;\ j, m\epsilon J = \{0, 1, \ldots 3\}, \quad (8)$$

where $\hat{P}_{j/mj}(x)$ is the predicted conditional propensity score of a plot under scheme *j* as opposed to an alternative *m* (without a scheme or with another scheme). We want to evaluate the impact of the CF scheme in comparison with no scheme. In addition, we want to compare the impact of each scheme with the impact of the other scheme(s). Thus, we make seven pairwise comparisons.

Following Lechner (2002), estimation of ATT with multiple treatments can be extended to

$$ATT^{j/m} = E\{Y_j - Y_m \big| J = j\} \forall m \neq j;\ j, m\epsilon J = \{0, 1, \ldots 3\}. \quad (9)$$

In our case, $ATT^{j/m}$ estimates the expected average effects of participating in CF scheme *j*, compared with the alternative, m.

To match treatment and control plots, we use nearest neighbor matching (NNM) and kernel matching (KM), two algorithms commonly used for empirical analysis (Caliendo and Kopeinig 2008). NNM involves choosing a partner from the control group for matching with each treated household or individual, based on propensity scores. Appendix Figure A.1 shows the propensity score distribution and common support for plots under a CF scheme and those under no scheme, based on NNM. KM uses nonparametric techniques to compare treated and control households based on kernel-weighted averages (Caliendo and Kopeinig 2008). In addition, we use a third set of matching techniques, inverse-probability-of-treatment weighting (IPTW) , which has been used frequently to reduce selection bias in studies with observational data and produces unbiased estimates with small samples (Pirracchio, Resche-Rigon, and Chevret 2012; Hirano and Imbens 2001; Imbens 2000).

It should be stressed that matching techniques build on the conditional independence assumption, which is also called selection on observables (Rosenbaum and Rubin 1983). This means that the method controls only for observed heterogeneity between treatment and control households. Estimates of the ATT may still be biased when there is unobserved heterogeneity. We test for the influence of such hidden bias by calculating Rosenbaum bounds (Becker and Caliendo 2007; DiPrete and Gangl 2004). Our estimations show that the critical value for bias from unobserved heterogeneity is high (more than 10 in most cases), indicating that the results are not sensitive to a bias caused by unobserved heterogeneity. The lower bound of > 10 means that matched farmers and plots with the same observed covariates would have to differ in terms of unobserved covariates by a factor of more than 10 in order to invalidate the inference on a significant treatment effect.

The second set of techniques used to control for unobserved heterogeneity is the IV approach. Instruments used are the proportion of scheme *j* participants in the village, minus the farmer under consideration, *i.* The idea is that farmers are likely to observe and follow their neighbors' practices (the peer effect). In addition, whether or not the scheme includes a joint liability group, it still requires a minimum number of participants to be operational. If most farmers stop participation in a scheme, the scheme will likely stop for all (even if two or three of them would prefer to continue). These instruments are also unlikely to affect the outcome variables directly, aside from their indirect effect through farmer *i*'s scheme *j* participation. The minimum condition for these instruments to be valid is that they be sufficiently correlated with the endogenous variables (Verbeek 2004, 148). This correlation can be tested by estimating the first-stage regression of each endogenous variable on the instruments used and performing an *F* statistic test (Verbeek 2004, 145). Stock and Watson (2003), cited in Verbeek (2004, 148), suggested that a minimum *F* statistic of 10 is sufficient for validity. The *F* statistic test results (*F* statistic = 53.1) confirm that the instruments used are strongly correlated with the endogenous variables instrumented. We also test the validity of these instruments using a simple falsification test following Di Falco, Veronesi, and Yesuf (2011) and Shiferaw and colleagues (2014). Results show that the instruments considered are statistically significant in the scheme participation models but not in the technology adoption, productivity, and profitability models, suggesting that the instruments are valid.

We conduct a Wu-Hausman *F* statistic test to determine whether scheme participation is, in fact, exogenous or endogenous in the outcome estimation models. We are able to reject the null hypotheses that participation is exogenous (*p* values are less than .01). This means that the endogeneity among these regressors would have deleterious effects on ordinary least squares (OLS) estimates. To address the forbidden regression problem with binary response as the endogenous variable in the first-stage model and using the predicted probability for the second-stage regression, we follow the approach of Adams, Almeida, and Ferreira (2009). We use a multinomial probit model for the first-stage model and then compute for the predicted probabilities. We run an OLS with scheme participation as the dependent variable and using the predicted probabilities and other covariates, excluding the instruments, as the explanatory variables. Last, we run the outcome variable model as the usual second-stage regression, using the predicted probabilities from the OLS regression.

We used several other techniques for additional robustness checks, including a linear probability model to predict participation, based on Angrist (2000), who showed that this type of model is consistent and is safer than using a probit or logit model, which is consistent only if the model is exactly correct. We also used the Mundlak-Chamberlain device (Mundlak 1978; Chamberlain 1984), also known as correlated random effects; the control function approach; and fixed effects (both village and household fixed effects). Mundlak-Chamberlain allows for correlation between the unobserved individual omitted variable and variables of interest (scheme participation), provided the unobserved effect is time invariant. The control function method entails taking the residuals from a reduced-form model of scheme participation and including them as a covariate in the structural model of technology adoption, productivity, and profitability. The impact of the control function method and other coefficients is similar to that of the IV models; therefore we present only the IV results.

Study Area and Sampling

This study focuses on the Upper West region in Ghana, where outgrower schemes were concentrating at the time of the survey. Mainly because of these schemes, the region has the largest adoption of hybrid maize seeds in Ghana, 19 percent, compared with only 3–5 percent in the major maize-producing areas of the Brong-Ahafo and Northern regions (IFPRI and SARI 2013).

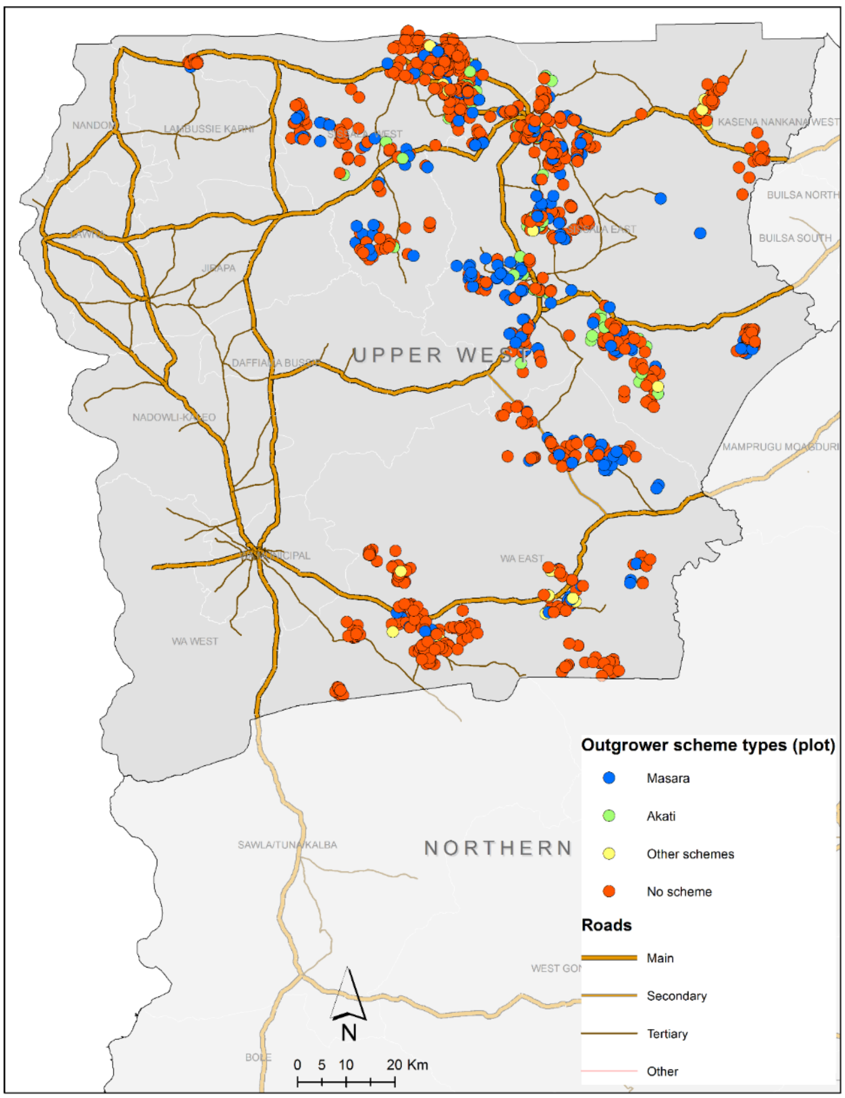
This region has the highest level of poverty in Ghana, with 70.7 percent of its population living below the poverty line in 2013 (Ghana Statistical Service 2014). The population is largely rural and depends mostly on subsistence agriculture. Agroecologically, the region belongs to the West African semiarid savannah, with a unimodal rainfall pattern of one wet and one dry season per year (Rademacher-Schulz, Schraven, and Mahama 2014). Yet maize is a main staple crop in the Upper West region, whose dry climate allows maize to be more easily dried and preserved, making it less prone to problems of mold and aflatoxin contamination (personal communication with Masara management, 6 23 2016). Moreover, the area faces a range of market failures, making CFAs attractive to both aggregators and smallholder farmers. These are mostly organized as interlinked contracts, in which inputs are provided in kind to the farmers and the costs of these inputs are subtracted from the price paid for the harvest.

Data were collected in February–March 2016 in three districts (Sissala East, Sissala West, and Wa East) in the Upper West region of Ghana. These are the districts with the highest maize production and the highest concentration of maize CF schemes in Upper West (based on official Ministry of Food and Agriculture production data from 2014 and field data from IFPRI teams in 2015). For each district, data were collected using a two-step stratified random sampling method. First, all communities were listed and categorized into two strata: those with and those without a CF scheme. A total of 13 communities were randomly selected per district, with the number of villages selected per stratum proportional to the total number of villages per stratum.

Second, for each community, a full listing of maize-growing households was compiled with the help of agricultural extension agents and community informants. In the without-scheme communities, 15 maize-growing households were randomly selected. In the with-scheme communities, households were divided into strata according to scheme membership, after which there was a random selection of households within each stratum. After removal of households with incomplete information, the sample totaled 1,261 households. Figure 3.1 shows the two main maize plots for each household included in the dataset, classified according to scheme participation.

The household questionnaire contained different modules that asked about socioeconomic and farm characteristics. Households were asked to list all their maize plots and give detailed agronomic information about two of them. If a household cultivated more than two maize plots, two main maize plots were selected and details were asked only about these two main maize plots. Production data were reported for the most recent season completed at the time of the survey (2015) and the prior year (2014) by recall. Data about assets were reported for the time of the survey, as well as recall data for one year prior and for the year 2010.

Figure 3.1 Distribution of sample maize plots and their scheme membership, Upper West region, Ghana, 2015



Source: Raw data from IFPRI and ISSER (2016).

Descriptive Statistics

As seen in Figure 3.1, the Masara scheme is present in all three districts. The Akate scheme is also present in the three districts, but we focus on Sissala East and Sissala West. There are several other schemes in all three districts. Most communities in Sissala East and West are with-scheme communities, while in Wa East, most are without-scheme communities. Some of these communities were under a scheme earlier but were not at the time of data collection. As seen in Figure 3.1, there is no obvious difference between villages with and without a CF scheme in terms of geographical spread and proximity to roads and major towns. Many villages had several CF schemes operating.

Table 3.1 shows the observable characteristics between with- and without-scheme households and plots. There seems to be small difference between those without a scheme and those with a scheme in terms of these observed characteristics and the geographical context. A few distinct differences are as follows. There is a greater proportion of female-headed households under no scheme. Among the scheme outgrowers, there is a greater proportion of female-headed households under Akate than other schemes. Contrary to what was expected, more without-scheme households are members of associations than with-scheme households. Those participating in a scheme listen to the radio more often and use the phone more often than those without a scheme. For other measures of connectivity (number of times going to town or market), however, there is no statistical significance between those with and without a CF scheme. There is no clear difference in terms of asset or wealth indicators between those under a scheme, taken in the aggregate, and those not under a scheme.

But for the outcome indicators, there seems to be a significant and substantial difference. Plots under a CF scheme are more likely to be treated with purchased inputs and improved technologies and to have higher productivity than those not under a scheme. There is also a huge difference in profits, but in the opposite direction: those under a scheme have significantly lower profits than those not under a scheme.

There are also significant differences across schemes. There is no significant difference in yield between Masara and Akate, but there is a huge difference between these schemes and other schemes (taken as aggregate) in their observable characteristics and outcome variables. Those under other schemes are more connected, have fewer assets, are nearer to input dealers and roads, and are older or more experienced in farming than those under the Masara or Akate schemes. Plots without a scheme are more prone to waterlogging and erosion than those under the Masara or Akate schemes. Plots under other schemes are less likely to be treated with purchased inputs, and in less quantity, and less likely to be cultivated with improved practices than those in the Masara and Akate schemes. They also have lower yields but higher average profits.

Table 3.1 Descriptive statistics of outcome and explanatory variables used in the estimations, pooled 2014 and 2015 data

Rows are the explanatory variables	No scheme (N = 2,295)	With scheme (N = 1,089)		Masara scheme (N = 831)		Akate scheme (N = 198)		Other scheme (N = 96)	
Gender of head (female= 1)	0.123	0.047	*	0.041	***	0.093		0.038	*
Years of formal education of head	1.831	2.440		2.547		2.261		2.329	
Household head can read and write (yes = 1)	0.119	0.181		0.209		0.169		0.136	
Age of head	44.257	42.469		41.421	**	38.380	**b	46.049	b
Years of farming experience of head	21.714	21.745		20.209	cc	18.597	bb	25.768	bb, cc
Any member hold political or traditional office (yes = 1)	0.400	0.368		0.393		0.274		0.364	
Number of adult members	3.371	3.473		3.352		3.445		3.695	
Head is member of association (yes = 1)	0.315	0.186	*	0.203	**	0.142	**	0.175	
Frequency of head's listening to radio[d]	1.917	1.596	*	1.491	***	1.534	***	1.806	
Frequency of head's going to nearest town[d]	2.415	2.377		2.323	a	2.162	***, a, bb	2.562	bb
Frequency of head's using phone[d]	2.080	1.763		1.554	***, ccc	1.736	*, b	2.138	b, ccc
Frequency of head's going to market[d]	2.397	2.410		2.320	cc	2.238	bbb	2.642	*, bbb, cc
Total livestock units[e]	3.530	3.473		4.413	ccc	3.510	b	1.823	**, b, ccc
Nonfarm landholdings (acres)[e]	1.808	1.060		1.441		0.694		0.556	**
Household asset index[e]	2.422	2.537		2.926	**, ccc	2.495	bb	1.879	**, bb, ccc
Nonfarm income (dummy)	0.511	0.638		0.719	***	0.566		0.527	
Total land size (acres)[e]	9.545	11.073		13.250	***, ccc	13.989	**, bbb	6.033	***, bbb, ccc
Household experienced shock (yes = 1)	0.654	0.503		0.476	**	0.583		0.515	
Community has agriculture project (yes = 1)	0.987	1.073		1.209	aaa	0.294	**, aaa, bbb	1.171	bbb
Community has electricity (yes = 1)	0.725	0.750		0.781	a	0.633	a	0.746	

Table 3.1 Continued

Rows are the explanatory variables	No scheme (N = 2,295)	With scheme (N = 1,089)		Masara scheme (N = 831)		Akate scheme (N = 198)		Other scheme (N = 96)	
Distance to nearest input shop (km)	42.443	35.916		46.534	a, cc	30.010	a	19.991	**, cc
Distance to nearest road (km)	6.976	0.341		0.091		2.081		0.029	
Plot size (acres)	3.961	4.420		5.579	***, ccc	4.420	bbb	2.044	***, bbb, ccc
Waterlogging is a problem in the plot (yes = 1)	0.125	0.147		0.078	**, ccc	0.053	**, bbb	0.309	**, bbb, ccc
Erosion is a problem in the plot (yes = 1)	0.155	0.158		0.115	cc	0.098	bb	0.260	bb, cc
Plot is not fertile (yes = 1)	0.534	0.493		0.518		0.325	***	0.520	
Yield (kg/acre)	**503.334**	**1,027.455**	***	**1,180.664**	***, ccc	**1,234.713**	***, bbb	**671.881**	***, bbb, ccc
Yield (metric tons/ha)	**1.243**	**2.536**	***	**2.911**	***, ccc	**3.052**	***, bbb	**1.661**	***, bbb, ccc
Profit (GHS/acre)	**151.864**	**6.865**	***	**-24.438**	***	**15.369**	**	**57.642**	
Used chemical fertilizer (Yes = 1)	**0.788**	**0.987**	***	**0.996**	***	**0.997**	***	**0.965**	**
Nitrogen (kg/acre)	**17.900**	**44.145**	***	**52.949**	***, aaa, ccc	**44.705**	***, aaa, bbb	**28.595**	***, bbb, ccc
Used modern varieties (yes = 1)	**0.703**	**0.915**	***	**1.000**	***, c	**0.985**	***, b	**0.737**	b, c
Used Pannar varieties (yes = 1)	**0.051**	**0.754**	***	**0.982**	***, aaa, ccc	**0.866**	***, aaa, bbb	**0.310**	***, bbb, ccc
Used certified seeds (yes = 1)	**0.120**	**0.883**	***	**1.000**	***, aa, ccc	**0.951**	***, aa, bb	**0.650**	***, bb, cccc
Planted 1 seed per hole, by row (yes = 1)	**0.118**	**0.638**	***	**0.743**	***, ccc	**0.825**	***, bbb	**0.375**	***, bbb, ccc

Source: Raw data from IFPRI and ISSER (2016). GHS=Ghanaian cedis.
Note: Figures are averages (means), weighted using sample weights. Asterisks indicate significant difference in means between no-scheme and with-scheme plots, and between no scheme and the specific schemes at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Letter a indicates significant difference in means between Masara and Akate schemes at a $p < 0.10$, aa $p < 0.05$, aaa $p < 0.01$. Letter b indicates significant difference in means between Akate and other schemes at b $p < 0.10$, bbb $p < 0.05$, bbb $p < 0.01$. Letter c indicates significant difference in means between Masara and other schemes at c $p < 0.10$, cc $p < 0.05$, ccc $p < 0.01$. d Likert scale from 1 to 5, 1 = most frequent; e Figures are averages over 2010, 2014, and 2015.

4. ESTIMATION RESULTS AND DISCUSSION

Do Contract Farming Schemes Give Higher Yields and Profits?

In all models, CF schemes (taken in aggregate) have significant impacts on technology adoption and yield improvements in maize (Table 4.1). Maize plots under a scheme are more likely to be treated with fertilizer and in greater quantities than plots not under a scheme. Masara and Akate outgrowers are provided with 5 bags of fertilizer (50 kg per bag) per acre, and other scheme outgrowers are provided on average 2.7 bags of fertilizer per acre (mainly Actyva [for Masara], NPK-15-15-15, or sulphate of ammonia). In contrast, nonscheme farmers use 2.3 bags of fertilizer per acre on average; 12 percent of nonscheme farmers do not use fertilizer. The main reasons for joining a CF scheme are to access fertilizers (reported by 3 out of 4 farmers) and to get improved seeds (reported by 59 percent of farmers). Timely access to inputs (22 percent), access to the market for grain (11 percent), extension services or technical assistance (7 percent), tractor services (6 percent), and a stable price for maize (1 percent) were also reported as main reasons for joining a scheme.

Scheme participation seems to be helping to address failures in the fertilizer and credit markets. CF schemes provide informal credit for the participants in an area in which failures of the credit market are serious. Table 4.2 shows the major constraints reported by maize-producing households. High cost of fertilizer is by far the major constraint reported; 43 percent of households ranked it as the most important constraint, and 80 percent considered it among the top three constraints. Eighty-two percent of households rated it as a very serious constraint (a 5, based on a 5-point Likert scale). Other major constraints are difficulty in getting loans/credit, difficulty in getting tractor services, the high cost of loans, and difficulty in accessing fertilizer, all reported by about one-third of households. A total of 60–70 percent of households rated the high cost of credit or difficulty in getting credit as a very serious constraint (5 on the Likert scale). A total of 34–37 percent of households rated difficulty in accessing tractor services and uncertainly in the timing of these services as a very serious constraint (5 on the Likert scale). Scheme participation seems to increase the likelihood of accessing and using higher quantities of fertilizer, and of accessing credit.

Table 4.3 shows households' ratings of the availability of inputs, in both quantity and quality, and their access to these inputs. Overall, availability of and access to inputs (seed, fertilizer, herbicide, manure, and labor) are generally good, as seen in Table 4.3, which seems to be in contrast to Table 4.2 and other findings pertaining to the severity of agriculture-related constraints. The only input that seems to have some issues in availability and access is tractor services. There is no significant difference across scheme types. Interpreting Tables 4.2 and 4.3 together, it seems that the timing, availability, and quality of fertilizer is not so much as of an issue as its cost, which is considered the most binding constraint among the sample households. It also seems that the quantity, availability, timing, and quality of seeds are not so much an issue to the majority of sample households, but the main issue with seeds is their cost. In both tables, tractor services are consistently cited as among the most serious constraints by the majority of maize-producing households in the study areas. There is also evidence that scheme participation in Masara and Akate is contributing to better access to and timing of tractor services, compared with not participating in any scheme, although there is no clear evidence about participation in Masara and Akate versus other schemes.

Under Masara, 98 percent of plots are planted with Pannar as part of the package; 2 percent of plots under Masara are planted with Obatanpa (made available to new participants in 2015). Almost all of the Akate scheme plots are planted with Pannar or Obatanpa. Other-scheme plots are more likely to be planted with hybrid seeds (Pannar) and certified seeds than no-scheme plots. Three out of four other-scheme plots are planted with modern varieties, and 31 percent are planted with hybrid seed, compared with only 5 percent of nonscheme plots. There is high adoption of modern varieties (73 percent) even among nonscheme growers.

Plots under a scheme are also more likely to be treated with improved management practices (such as one seed per hole, dibbling, row planting, and proper spacing between plants and between rows) than nonscheme plots. Three out of four Masara or Akate scheme plots use improved production practices, compared with 38 percent of other-scheme plots and only 12 percent of those under no scheme. Part of the CF scheme package is to provide technical assistance and extension services to participants as an added incentive to the farmers and the firms. Technical assistance means greater yields and therefore a greater supply of grain for the firm to buy and greater likelihood of repayment.

The impact of scheme participation on maize yield is 400–800 kg/acre (Table 4.1). Recall that average yield is 1.3 metric tons/acre, or 2.5 tons/ha, for scheme outgrowers, on average, compared with 0.5 tons/acre, or 1.2 tons/ha, for nonscheme outgrowers (Table 3.1). The Masara and Akate schemes have a higher impact on maize yields than other schemes. The average yield for Masara and Akate outgrowers is 2.9 to 3.1 tons/ha, whereas the average for other-scheme outgrowers is 1.7 tons/ha (Table 3.1).

Despite significant positive impacts on technology adoption and yield, the impact of CF on profits is negative on average. The impact of scheme participation ranges from -180 to -250 Ghanaian cedis (GHS) per acre on average. No-scheme growers make GHS 150/acre in profits, while scheme outgrowers have negligible profits (GHS 6 for all schemes; GHS -24 for Masara, GHS 15 for Akate, and GHS 58 for other schemes) (Table 3.1). On average, households harvest 29–30 bags (100 kg each) of maize per hectare, or 2.9–3.0 tons per hectare, and the required repayment for fertilizer, seed, herbicide, and materials provided up front under a CF scheme is 21–25 bags (50 kg each) per acre, or 2.6–3.0 tons per hectare, which leaves almost none for home consumption or for sale. There is no statistical difference in the impact on profits across schemes.

Table 4.1 Regression results on the impact of scheme participation on technology adoption, productivity, and profitability

Variable	Kernel matching		*Critical level of hidden bias*	Nearest-neighbor matching		Inverse-probability-of-treatment weighting		Instrumental variable approach	
	ATT	SE		ATT	SE	ATT	SE	ATT	SE
All with scheme versus no scheme									
Yield	458.35***	19.01	*> 10*	424.99***	23.79	449.53***	18.30	787.80***	65.00
Profit	-241.62***	16.08	*2*	-234.89***	22.46	-245.97***	15.49	-178.44***	49.44
Nitrogen	24.22***	0.62	*> 10*	22.70***	0.84	24.20***	0.63	42.51***	2.49
Modern	0.36***	0.01	*> 10*	0.34***	0.02	0.36***	0.01	0.54***	0.06
Hybrid	0.83***	0.01	*> 10*	0.83***	0.01	0.83***	0.01	1.00***	0.07
Certified modern	0.86***	0.01	*> 10*	0.86***	0.02	0.86***	0.01	1.00***	0.07
Improved practices	0.51***	0.02	*10*	0.39***	0.02	0.52***	0.02	1.29***	0.07
Masara versus no scheme									
Yield	502.09***	17.89	*> 10*	486.08***	24.83	490.71***	20.37	800.06***	74.20
Profit	-247.95***	14.35	*2*	-231.92***	21.69	-253.91***	17.80	-189.07***	54.65
Nitrogen	27.26***	0.64	*> 10*	25.61***	0.86	27.00***	0.68	48.62***	3.02
Modern	0.37***	0.01	*> 10*	0.34***	0.02	0.36***	0.01	0.57***	0.07
Pannar	0.53***	0.02	*> 10*	0.42***	0.03	0.90***	0.01	1.03***	0.08
Certified modern	0.89***	0.01	*> 10*	0.89***	0.02	0.89***	0.01	1.03***	0.08
Improved practices	0.53***	0.02	*10*	0.42***	0.03	0.53***	0.02	1.25***	0.08
Akate versus no scheme									
Yield	487.86***	51.30	*> 10*	487.86***	51.30	450.77***	31.52	652.83***	124.00
Profit	-218.45***	32.19	*2*	-211.26***	44.42	-305.89***	30.45	-192.82**	93.32
Nitrogen	19.85***	1.24	*> 10*	20.73***	2.17	24.99***	1.22	28.01***	5.29
Modern	0.36***	0.02	*> 10*	0.35***	0.05	0.36***	0.01	0.56***	0.12
Pannar	0.56***	0.03	*> 10*	0.39***	0.05	0.83***	0.03	0.97***	0.13
Certified modern	0.85***	0.02	*> 10*	0.88***	0.03	0.86***	0.01	0.85***	0.14
Improved practices	0.56***	0.03	*10*	0.37***	0.07	0.61***	0.03	1.14***	0.14
Other schemes versus no scheme									
Yield	-44.33	38.98	*> 10*	-86.35	69.58	86.01	103.64	142.81	188.58
Profit	-246.04***	31.87	*2*	-266.86***	59.58	-351.78***	45.26	-337.78**	132.92
Nitrogen	5.58***	1.69	*> 10*	7.06***	2.51	23.13***	8.64	24.05***	9.01
Modern	0.26***	0.04	*> 10*	0.25***	0.08	0.29***	0.05	0.50**	0.20
Pannar	0.29***	0.05	*> 10*	0.37***	0.07	0.16***	0.15	0.74***	0.22
Certified modern	0.69***	0.04	*> 10*	0.73***	0.06	0.24	0.20	1.04***	0.23
Improved practices	0.29***	0.05	*10*	0.37***	0.07	0.08	0.17	0.61***	0.24

Table 4.1 Continued

Variable	Kernel matching		*Critical level of hidden bias*	Nearest-neighbor matching		Inverse-probability-of-treatment weighting		Instrumental variable approach	
	ATT	SE		ATT	SE	ATT	SE	ATT	SE
Masara versus Akate									
Yield	-32.08	46.69	*> 10*	39.82	75.67	39.93	34.27	130.39	135.51
Profit	-21.39	41.46	*2*	34.34	62.09	51.98	32.67	-6.51	100.18
Nitrogen	3.53*	1.76	*> 10*	1.26	1.90	5.83***	1.44	20.16	5.69
Modern	0.01	0.01	*> 10*	0.01	0.01	0.02*	0.01	0.00	0.13
Pannar	0.01	0.05	*> 10*	-0.06	0.07	0.10***	0.02	0.08	0.14
Certified modern	0.05*	0.02	*> 10*	0.04*	0.02	0.04***	0.01	0.16	0.15
Improved practices	0.01	0.05	*10*	-0.06	0.07	0.08**	0.04	0.14	0.15
Masara versus other schemes									
Yield	564.94***	54.18	*> 10*	575.74***	120.28	404.69***	104.31	662.98***	165.32
Profit	-27.92	33.58	*2*	34.34	55.49	97.86**	46.72	144.55	116.03
Nitrogen	23.81***	2.59	*> 10*	19.32	15.05	12.13	10.09	24.08***	7.96
Modern	0.13**	0.04	*> 10*	0.15	0.12	0.11**	0.05	0.06	0.17
Pannar	0.25***	0.06	*> 10*	0.26**	0.12	0.75***	0.12	0.28	0.20
Certified modern	0.28***	0.06	*> 10*	0.35***	0.12	0.48**	0.19	-0.01	0.20
Improved practices	0.25**	0.11	*10*	0.41*	0.21	0.27*	0.16	0.62***	0.21
Akate versus other schemes									
Yield	580.39***	94.81	*> 10*	303.67	328.63	364.76***	106.95	532.59***	204.85
Profit	57.00	71.98	*2*	-169.05	285.65	45.88	52.64	151.06	143.99
Nitrogen	16.81***	3.60	*> 10*	19.32	16.20	6.30	10.10	3.92	9.56
Modern	0.11*	0.07	*> 10*	0.08	0.11	0.09*	0.05	0.05	0.21
Pannar	0.25**	0.11	*> 10*	0.41	0.31	0.65***	0.12	0.21	0.24
Certified modern	0.28**	0.09	*> 10*	0.23	0.30	0.44**	0.19	-0.17	0.24
Improved practices	0.25**	0.11	*10*	0.41	0.34	0.35**	0.16	0.49*	0.25

Source: Raw data from IFPRI and ISSER (2016).
Note: Significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Critical value of hidden bias is similar for kernel matching, nearest-neighbor matching and inverse-probability-of-treatment weighting. ATT = average treatment effect on the treated; SE = standard error.

Table 4.2 Proportion of farmers reporting maize-related constraints they face, 2015, in percentages

Constraint	Most important	Second most important	Third most important	In top three constraints (total)
High cost of fertilizer	43.5	22.3	15.3	81.1
Difficulty of getting credit/loan	12.0	14.0	10.7	36.7
Difficulty of getting tractor services	11.4	9.0	14.8	35.2
High cost of credit/loan	8.6	14.5	8.3	31.4
Difficulty in accessing fertilizer	9.8	12.0	6.5	28.4
Low output price	5.0	6.4	6.5	17.9
High cost of preferred seed	1.1	4.5	7.5	13.1
Uncertainty in timing of tractor services	1.1	4.3	4.7	10.2
Difficulty in getting technical advice or extension services on new technologies	1.5	3.6	4.4	9.5
Uncertainty in timing of fertilizer	0.2	1.9	2.9	5.1
Uncertainty in supply of fertilizer	0.4	0.9	3.6	4.9
No buyers/market	2.1	0.6	1.4	4.2
Uncertainty in quality of advice	0.1	1.3	2.1	3.5
Uncertainty in output price season after season	0.2	1.6	1.6	3.4
Difficulty of getting preferred seed	0.2	1.1	1.6	3.0
Do not know what is good variety or seed	0.3	0.1	0.7	1.1
Uncertainty in buyers/market season after season	0.0	0.4	0.5	0.9
Uncertainty in quality of seed season after season	0.1	0.3	0.3	0.7
Uncertainty in supply of preferred seed	0.1	0.2	0.0	0.3

Source: Raw data from IFPRI and ISSER (2016).

Table 4.3 Proportion of maize-growing households reporting access to key inputs, 2014 and 2015, in percentages

	2015					2014				
Input	No scheme	Masara	Akate	Other scheme	Total	No scheme	Masara	Akate	Other scheme	Total
Seed										
Was it available at the time needed?[a]	98	99	92	92	98	97	98	98	97	98
Was there enough quantity available for you to buy?[a]	94	98	92	92	95	92	99	96	98	95
Were you able to buy the type or variety you wanted?[a]	90	97	96	89	93	89	98	99	100	93
How do you rate the quality available?										
Good, no problem	89	91	96	93	90	88	92	99	94	90
Some problems	10	8	4	5	8	10	7	1	6	8
Poor, serious problems	2	1	0	2	1	2	1	0	0	1
Fertilizer										
Was it available at the time needed?[a]	85	95	89	96	89	85	95	90	98	89
Was there enough quantity available for you to buy?[a]	91	97	90	97	93	91	96	91	96	93
Were you able to buy the type or variety you wanted?[a]	95	99	96	96	97	95	99	99	99	97
How do you rate the quality available?										
Good, no problem	83	91	93	90	87	83	92	96	89	87
Some problems	15	8	7	6	12	15	8	4	10	12
Poor, serious problems	2	1	0	4	1	2	1	0	1	1
Tractor service										
Was it available at the time needed?[a]	59	66	70	75	63	59	66	72	71	63
Was there enough quantity available for you to buy?[a]	66	72	74	62	69	68	70	75	61	69
Were you able to buy the type or variety you wanted?[a]	93	97	95	89	94	92	97	98	97	94
How do you rate the quality available?										
Good, no problem	75	80	85	75	78	74	81	86	74	78
Some problems	21	16	13	22	18	21	15	11	26	18
Poor, serious problems	4	4	2	3	4	5	4	3	0	4

Table 4.3 Continued

Input	2015					2014				
	No scheme	Masara	Akate	Other scheme	Total	No scheme	Masara	Akate	Other scheme	Total
Labor										
Was it available at the time needed?[a]	96	98	98	97	97	96	97	98	95	97
Was there enough quantity available for you to buy?[a]	95	97	97	97	96	95	97	98	95	96
Were you able to buy the type or variety you wanted?[a]	98	98	97	100	98	98	98	98	100	98
How do you rate the quality available?										
Good, no problem	93	94	97	92	94	94	94	98	85	94
Some problems	6	5	3	8	6	6	5	2	11	6
Poor, serious problems	1	0	0	0	0	0	1	1	3	0

Source: Raw data from IFPRI and ISSER (2016).
Note: [a] Percentage of those responding yes to the question.

Who Stays and Who Exits the Schemes?

We also compare impact by year, 2014 versus 2015 (Table 4.4). The impact of schemes on yields and profits are similar for both years and similar to the models with pooled data for 2014 and 2015.

Table 4.4 Impact of scheme participation on yield and profit, 2014 versus 2015

Variable	2015		2014	
	Coeff.	SE	Coeff.	SE
All with scheme versus no scheme				
Yield	460.60***	23.93	455.67***	25.94
Profit	-236.36***	22.08	-248.15***	18.06
Masara versus no scheme				
Yield	510.36***	25.75	493.54***	29.45
Profit	-237.82***	23.11	-259.57***	26.64
Akate versus no scheme				
Yield	508.93***	43.98	500.42***	58.95
Profit	-199.47***	44.59	-236.93***	40.72
Masara versus Akate				
Yield	-1.42	64.05	-44.63	99.66
Profit	-9.61	55.90	-14.44	88.96

Source: Raw data from IFPRI and ISSER (2016).
Note: Significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Other combinations related to other schemes were not computed due to small sample sizes. SE = standard error.

We also look at households that exited the scheme in 2015 (Table 4.5 and Figure 4.1). Of 2014 Masara outgrowers, 22 percent exited the scheme in 2015. Most of them continued to plant maize under no scheme, some did not grow maize, and a few shifted to Akate or other schemes. Of the 2014 Akate outgrowers, 11 percent exited, and 46 percent of the other-scheme outgrowers exited in 2015. One possible reason for the latter is the discontinuation of support from SADA to the aggregators or farmers, which may have led the other outgrower schemes to narrow or discontinue their operations (based on interviews with key informants).

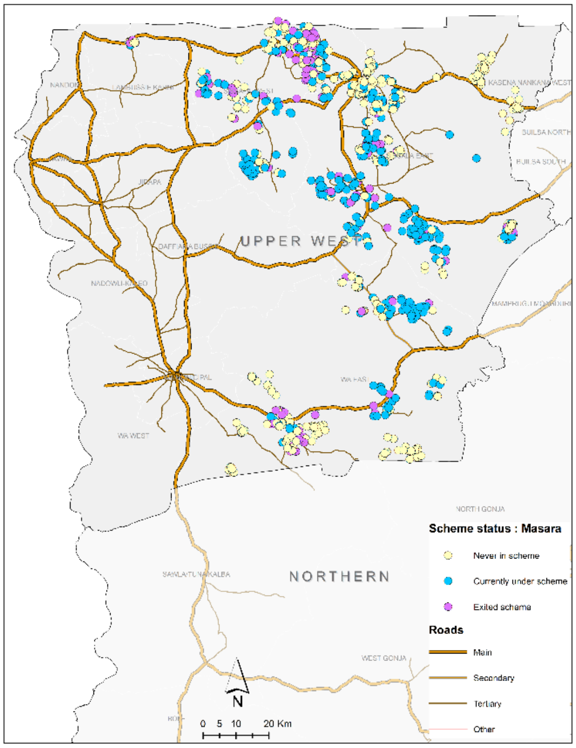
Table 4.5 Percentage of households exiting schemes

2014	2015			
	No scheme	Akate	Other scheme	Did not grow maize
Masara	14.0	1.2	0.3	6.5
Akate	5.5	0.0	0.0	5.5
Other scheme	46.0	0.0	0.0	0.0

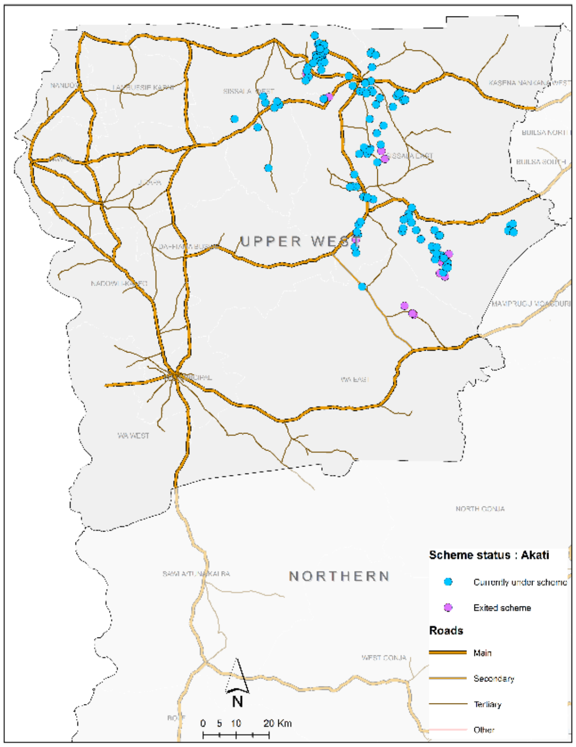
Source: Raw data from IFPRI and ISSER (2016).

Figure 4.1 Map of sample households and their scheme participation

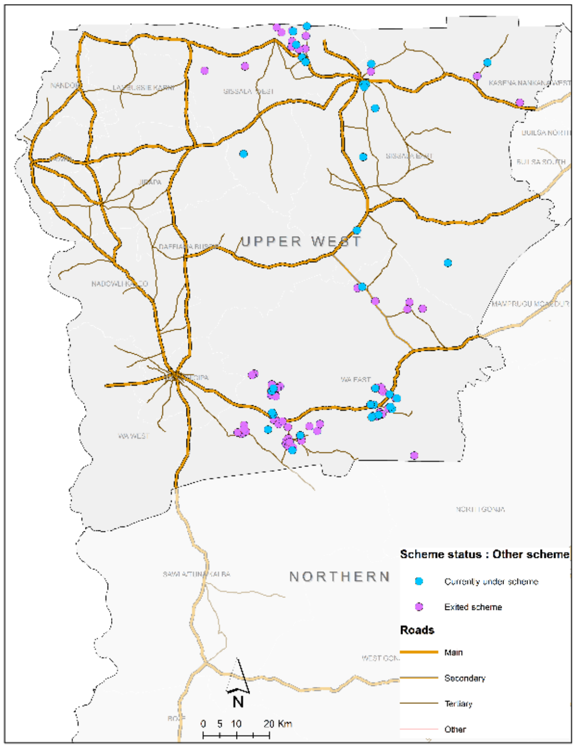
(a) Stayers, movers, and those who never participated in Masara scheme



(b) Stayers and movers in Akate scheme



(c) Stayers and movers in other schemes



Source: Raw data from IFPRI and ISSER survey (2016).

Masara or Akate plots that left the scheme in 2015 had much lower 2014 yields and profits than those that continued in 2015. Their profits, in fact, were negative compared with those that continued; this lack of profitability is likely the reason for scheme exit decisions by some farmers. Lambrecht and Ragasa (2016) showed that the reason most cited for scheme exit is high required repayment for the inputs received, which keeps many maize outgrowers in the focus districts from achieving positive profits. These authors showed that by 2015, the proportion of households that had exited CF in the focus districts was higher than the proportion currently participating. On average, farmers participating in CF schemes in 2015 had been members for 2.7 years, while those that had exited schemes by 2015 had spent on average 1.3 years in CF (Lambrecht and Ragasa 2016). These findings indicate that despite low or negative profits for a given year, some farmers who continue in CF seem to be averaging out their expected profits over the several years since they joined the scheme; more recent entrants, on the other hand, seem to be less patient and to exit more quickly.

Those who left the scheme had lower yields in 2015 than in 2014, but higher profits, although profits were significantly different only under the Masara scheme (Table 4.6). On average, Masara dropouts had greater profits after exiting the scheme in 2015 than when they were under the scheme in 2014. Those who stayed in the Masara scheme in 2015 had a slight reduction in yields and profits in 2015 compared with 2014, which may threaten their incentive to continue participation in the scheme.

Table 4.6 Comparison of profitability of households exiting schemes in 2015

	2014			2015			
Variable	**Stayed in 2015**	**Exited in 2015**		**Stayed in 2015**		**Exited in 2015**	
Masara	*N = 315*	*N = 90*		*N = 314*		*N = 63*	
Yield (kg/acre)	1,269.54	1,018.59	*	1,208.91		849.40	**
Profit (GHS/acre)	33.94	-150.95	***	-23.22	*	305.40	***
Akate	*N = 76*	*N = 11*		*N = 76*		*N = 5*	
Yield (kg/acre)	1,257.97	1,106.44		1,228.75		618.29	*
Profit (GHS/acre)	27.15	-93.35		22.20		136.81	
Other scheme	*N = 22*	*N = 21*		*N = 22*		*N = 21*	
Yield (kg/acre)	589.99	646.83		648.90		453.47	*
Profit (GHS/acre)	7.64	2.36		31.20		30.52	

Source: Raw data from IFPRI and ISSER (2016).
Note: GHS=Ghanaian cedi.

Who Gets Positive Profits from Contract Farming Schemes?

One-quarter of the households not participating in CF have negative profits, compared with more than half of CF scheme participants. Although the impact of scheme participation on profits is negative on the average, many farmers do get high profits from their scheme participation (Table 4.7). Of those in the Masara scheme, 21 percent had high profits (> GHS 200/acre) and 8 percent had very high profits (> GHS 500/acre). These high profits within schemes are mainly driven by high yields, suggesting that a subset of farmers who experience high yields from the improved technologies promoted by the CF schemes benefit substantially and would likely continue with the scheme. However, the majority of farmers, especially those who experience low yields even under the CF scheme, have negative or very low profits and would likely drop out or try for one more season to see if things improve.

Table 4.7 Proportion of households based on profitability in schemes

Status	Percentage of HHs with - or 0 profits	Percentage of HHs with + profits	Percentage of HHs with > GHS 200/acre profits	Percentage of HHs with > GHS 500/acre profits
With no scheme	27	73	43	17
With any scheme	56	44	21	9
With Masara scheme	57	43	21	8
With Akate scheme	53	47	23	11
With other scheme	55	45	16	4

Source: Raw data from IFPRI and ISSER (2016).
Note: GHS = Ghanaian cedis; HH = household.

We next examine what explains the variation in yields and profits within schemes, and which households are getting higher yields and profits under each scheme (Table 4.8). Under the Masara scheme, households with a male head have higher yields and profits. Households that experienced shocks, or experienced more shocks, have lower yields and profits from their Masara scheme maize plots. Households with nonfarm income have lower profits. Households with more livestock units have higher yields and profits. Indicators of connectivity are mixed. Households who frequently use a radio have lower yields and profits, but those whose head frequently goes out of town have higher yields and profits under the Masara scheme. Plots considered not fertile have lower profits. Plots reported to have a waterlogging problem have higher yields, an unexpected result. Plot reported to have an erosion problem have lower yields and profits. Communities with electricity have higher yields and profits, but households in communities with agricultural projects have lower profits, another unexpected result.

Under the Akate scheme, households with more household assets have higher yields. Plots without land titles or deeds have higher yields and profits, which is not expected. Those who frequently use a phone and those with better connectivity have higher profits. Plots reported to have a waterlogging problem have lower yields and profits under Akate, but plots with an erosion problem have higher yields under Akate, which is not expected. Households farther from a road have lower yields and profits under Akate, but those farther from input dealers have higher profits.

Under other schemes, households with younger heads have higher yields and profits. Households whose heads have fewer years of formal schooling are more productive, which is not expected. Households with a head who is a member of an association have lower profits under other schemes than those whose heads are not members of an association, which is not expected. Households that experienced a shock and those with more frequent shocks have lower profits and yields under other schemes. Household size is associated with higher yields and profits under other schemes. Under other schemes, households in communities with electricity have higher profits.

We also look at prices received for harvested maize. The average price received for maize in no-scheme households was GHS 0.92 per kg; those under a scheme received GHS 0.91 per kg on average. Thus households not participating in CF received higher prices for their maize than those participating, and the difference is shown to be significant by using a *t*-test for simple mean comparison. However, the significance disappears when we control for village fixed effects, because prices vary widely by village. Thus it is likely that maize prices do not contribute much to explaining variations in profits within and across schemes.

What seems to be the main predictor of profit level within a CF scheme is the yield. Several management practices are strongly associated with higher yields within schemes (Table 4.9). For plots under any CF scheme, the use of more fertilizer, Pannar seed, certified seed, herbicide, and proper spacing and planting are associated with higher yield levels. Under the Masara scheme, which offers a fixed package, there is not much observed difference in input use and management practices. One clear difference is in proper spacing and planting, which are associated with higher yields under Masara. Under the Akate scheme, there is also not much difference in inputs and practices across participants, but the

Akate scheme has more flexibility than does Masara. The clear predictor of higher yields under Akate is the use of certified seeds. Proper planting and spacing shows a negative relationship with yield under Akate, which is not expected. Under other schemes, greater use of fertilizer and longer fallow years are significant predictors of yield. Under no scheme, fertilizer, certified seeds, herbicide, use of tractors, and longer fallow years are associated with higher yields. Surprisingly, slash-and-burn practices, which are being discouraged by extension workers, show a positive relationship with higher yields. The use of hybrids shows a significant relationship with higher yields, but this finding should be interpreted with caution because the proportion of those using imported or local hybrids is very small. Only 8 percent of no-scheme plots were planted with Pannar and 1 percent with local hybrids (Mamaba or Etubi) in 2015.

Table 4.8 Correlates of profits and yields within schemes (reduced form)

Predictor	Profit				Yield			
	All	Masara only	Akate only	Other schemes only	All	Masara only	Akate only	Other schemes only
Female head (yes = 1)	-65.008***	-178.162**	-79.11	6.93	-11.95	-191.341**	-171.67	118.53
	(24.964)	(76.004)	(151.755)	(126.971)	(30.190)	(82.028)	(169.392)	(212.930)
Age of head (years)	-0.260	2.253	5.172	-5.260*	-0.939	2.263	4.358	-8.832*
	(0.613)	(1.599)	(4.760)	(3.049)	(0.761)	(1.760)	(5.488)	(4.624)
Years of formal education of head		-0.197	16.196	-9.595	-9.595	-2.844	2.154	-46.533**
		(7.285)	(13.375)	(16.179)	(16.179)	(7.968)	(15.310)	(19.340)
Head can read and write (yes = 1)	36.716	60.844	9.509	(91.885)	13.482	112.760	111.214	158.590
	(35.006)	(76.551)	(152.901)	(155.735)	(41.495)	(85.361)	(174.508)	(236.324)
Head holds political or traditional office (yes = 1)	-1.631	11.092	-38.335	18.881	-3.458	33.906	-119.071	-30.200
	(15.481)	(35.711)	(73.829)	(65.331)	(18.373)	(39.572)	(85.958)	(92.324)
Head is member of association (yes = 1)	-55.769***	-32.705	-125.106	-138.709*	-82.143***	-39.448	-136.692	16.340
	(16.907)	(43.548)	(83.227)	(73.093)	(21.111)	(48.767)	(98.086)	(103.978)
Household experienced shock (yes = 1)	-81.597***	-57.641	15.632	-164.993**	-135.307***	-104.394**	39.784	-379.415***
	(16.157)	(39.874)	(71.778)	(82.031)	(19.004)	(44.693)	(82.321)	(115.099)
Adult members in household (number)	-9.927**	-9.303	-14.699	63.055***	-9.704*	-10.319	-12.754	61.673**
	(4.284)	(9.287)	(19.125)	(22.381)	(5.339)	(10.718)	(21.991)	(30.078)
Plot has written title/deed (yes = 1)	-6.801	-39.125	-231.013**	-129.630	49.676**	-10.787	-221.585*	113.154
	(21.527)	(47.824)	(105.867)	(148.982)	(24.743)	(53.405)	(115.766)	(155.828)
Household has nonfarm income (yes = 1)	-35.848**	-58.749*	-91.758	-60.548	-44.276**	-43.674	-117.318	-8.173
	(14.903)	(31.758)	(78.706)	(79.645)	(18.502)	(36.226)	(89.170)	(97.362)
Total livestock units (2010)	1.553**	2.428**	5.833	-3.473	1.104	2.241**	8.387	-1.662
	(0.611)	(1.017)	(7.141)	(3.861)	(0.998)	(1.125)	(8.415)	(5.324)
Total nonagricultural landholdings (acres) (2010)	0.370	0.094	8.181	18.730	0.977***	0.696	10.521	-5.598
	(0.397)	(0.742)	(8.118)	(15.191)	(0.319)	(0.853)	(8.478)	(24.797)
Household asset index (2010)	14.063**	7.669	47.662*	15.613	39.385***	8.031	52.543	27.583
	(6.075)	(15.541)	(28.414)	(36.173)	(7.842)	(16.796)	(32.107)	(55.759)
Frequency of head's using radio[a]	-17.501**	42.994**	-16.618	-64.121**	-8.856	53.635**	-18.087	18.139
	(7.424)	(19.076)	(40.688)	(30.994)	(9.985)	(22.536)	(48.080)	(43.192)
Frequency of head's going to town[a]	-26.500*	-62.880*	61.293	47.692	-37.469**	-93.924**	23.629	-30.620
	(14.089)	(35.978)	(66.774)	(80.719)	(17.141)	(40.552)	(76.920)	(105.658)
Frequency of head's using phone[a]	-17.033**	-9.271	-79.100*	-17.553	-22.061**	-17.270	-48.123	-60.698
	(8.057)	(22.402)	(45.491)	(40.289)	(10.649)	(25.934)	(52.196)	(51.742)

Table 4.8 Continued

Predictor	Profit				Yield			
	All	Masara only	Akate only	Other schemes only	All	Masara only	Akate only	Other schemes only
Plot is reported as not fertile (yes = 1)	-63.615***	-56.222*	-50.290	90.868	-66.897***	-47.027	-28.198	33.972
	(15.658)	(32.750)	(73.623)	(65.016)	(19.486)	(37.363)	(84.109)	(109.430)
Waterlogging is a problem in this plot	20.679	75.808	-173.255*	-42.065	7.032	119.970**	-293.897**	-123.714
(yes = 1)	(23.479)	(47.639)	(101.141)	(80.623)	(30.083)	(53.080)	(134.793)	(117.656)
Erosion is a problem in this plot (yes = 1)	-31.222	-93.465**	86.439	-40.940	-41.862	-89.961*	209.546*	-9.820
	(20.803)	(43.907)	(104.409)	(86.281)	(25.594)	(49.784)	(112.614)	(151.502)
Distance to nearest road (km)	0.365	-4.596	-30.227***	36.604***	-0.983	-1.661	-34.289***	-6.103
	(0.465)	(5.684)	(10.836)	(11.056)	(0.637)	(8.552)	(12.890)	(16.433)
Distance to nearest input dealer (km)	-0.556***	-0.380	4.160*	-1.146	-0.443*	-0.310	3.196	1.139
	(0.195)	(0.457)	(2.221)	(1.816)	(0.257)	(0.518)	(2.488)	(2.506)
Community has electricity (yes = 1)	37.673**	84.198**	-164.129	187.716**	13.463	96.191**	-142.930	54.688
	(16.842)	(33.948)	(105.202)	(86.889)	(21.590)	(39.534)	(119.748)	(156.388)
Community has agricultural project (yes = 1)	-12.285*	-25.611*	-23.025	-7.470	-5.009	-30.780*	-18.801	-10.538
	(6.638)	(14.950)	(41.044)	(47.405)	(8.251)	(17.237)	(46.939)	(68.595)
Constant	504.635***	152.676	-816.775*	399.762	761.446***	1,408.019***	708.973	1,868.058***
	(108.117)	(214.248)	(469.755)	(441.578)	(136.174)	(244.027)	(538.853)	(599.644)
N	**3,371**	**830**	**198**	**96**	**3,371**	**830**	**198**	**96**
R-squared	**0.069**	**0.084**	**0.25**	**0.472**	**0.208**	**0.086**	**0.258**	**0.412**

Source: Raw data from IFPRI and ISSER (2016).

Note: Significant at * p < 0.10, ** p < 0.05, *** p < 0.01. a Likert scale from 1 to 5, 1 = most frequent. Different models were estimated using different indicators. For example, we used dummy variables instead of Likert scales for frequency of head's listening to radio and other indicators; we also used other asset indicators such as total landholdings, soil type, soil nutrients, rainfall level and variations, and other community-level characteristics. Results are similar in terms of the variable or characteristic they represent; year and district dummies are included in the regressions. Scheme dummies (predicted values from the instrumental variables regression) are included in the models for all households.

Table 4.9 Relationship of yields to management practices within schemes

	Under scheme		Masara	Akate	Other schemes		No scheme	
Practice	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Nitrogen (kg/acre)	6.000***	7.105***		-0.190	11.502***	10.236***	11.323***	11.186***
	(1.013)	(1.018)		(2.074)	(2.459)	(2.555)	(0.790)	(0.790)
Nitrogen squared	-0.313*	-0.300		0.044	-0.808	-1.412	-0.376***	-0.366**
	(0.189)	(0.194)		(0.388)	(1.013)	(0.911)	(0.144)	(0.143)
Proper spacing, one seed per hole,	62.025	82.627**	79.565*	-224.905*	-69.930	12.075	49.260**	38.129
and row planting (yes = 1)	(39.396)	(39.573)	(46.250)	(117.094)	(87.616)	(77.368)	(24.959)	(24.313)
Herbicide use (yes = 1)	129.729	161.835*			70.102	41.408	106.848***	110.451***
	(80.497)	(88.069)			(102.593)	(104.539)	(22.695)	(22.299)
Tractor use (yes = 1)	40.937	66.517	4.254	42.249			41.968*	44.740**
	(54.798)	(54.877)	(76.615)	(127.105)			(21.807)	(21.621)
Slash-and-burn practices (yes = 1)	2.179	4.609	24.747	-135.759			75.367***	77.472***
	(47.843)	(48.371)	(58.424)	(89.407)			(21.749)	(21.236)
Variety (control: Obatanpa)								
Pannar (yes = 1)	270.725***		-18.483		41.999		61.110*	
	(54.119)		(101.652)		(99.148)		(35.501)	
Local variety (yes = 1)	-207.966				233.629		10.099	
	(160.578)				(302.475)		(21.332)	
Local hybrid (yes = 1)	23.471				-104.979		257.202***	
	(105.520)				(118.898)		(86.899)	
Other modern open-pollinated variety (yes = 1)	-350.742***				-238.252*		0.271	
	(93.428)				(120.127)		(27.999)	
Certified seed (yes = 1)		391.205***		753.439***	16.990	-55.864		89.550***
		(92.646)		(283.691)	(160.466)	(122.130)		(27.115)
Number of years under fallow (yes = 1)	-7.041	-8.087	-2.586	-36.224	43.826*	37.709*	13.516**	14.590**
	(13.370)	(13.245)	(16.114)	(31.747)	(22.093)	(19.250)	(6.835)	(7.012)
Waterlogging is a problem	29.514	22.553	65.696	-371.980**			29.709	27.965
in this plot (yes = 1)	(52.455)	(54.147)	(61.167)	(157.461)			(29.151)	(28.858)
Erosion is a problem	-39.440	-38.440	-103.209*	116.654			-16.046	-15.985
in this plot (yes = 1)	(51.358)	(49.876)	(59.117)	(118.325)			(26.644)	(26.624)

Table 4.9 Continued

	Under scheme		Masara	Akate	Other schemes		No scheme	
Practice	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Self-reported soil fertility status (control = fertile)								
Not fertile (yes = 1)	-57.100	-69.366*	-60.449	76.632			-63.380***	-65.758***
	(36.882)	(36.971)	(44.777)	(81.442)			(19.174)	(19.099)
Very fertile (yes = 1)	7.677	27.117	-89.451	433.310*			55.727	51.135
	(83.846)	(82.081)	(65.491)	(231.421)			(53.781)	(52.419)
Constant	-43,288.829	-20,920.728	1,358.373	-134,089.975	96,277.613	86,601.538	-29,097.078	-30,944.587
	(67,785.397)	(68,170.225)	(82,677.210)	(155,114.523)	(156,949.654)	(163,080.584)	(37,051.469)	(37,039.109)
No. of Obs.	***835.000***	***835.000***	***609.000***	***138.000***	***88.000***	***88.000***	***1,795.000***	***1,795.000***
R-squared	***0.147***	***0.126***	***0.018***	***0.189***	***0.294***	***0.249***	***0.288***	***0.288***

Source: Raw data from IFPRI and ISSER (2016).
Note: Significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Year and district dummies are included in the regressions.

Are the Yield and Profit Impacts Underestimated Because of Input Diversion?

Presurvey fieldwork indicated a phenomenon of outgrowers' diverting fertilizer3 received from CF schemes to other, non-CF plots, or selling them to other farmers. The household survey (IFPRI and ISSER 2016) directly addressed this issue by asking for quantities of inputs received from schemes and actual usage or application of inputs on maize plots. However, the survey revealed that only 20 percent of Masara scheme plots were noncompliant—that is, had lower actual fertilizer use than the recommended and provided 5 bags per acre—and most of these noncompliant outgrowers diverted 1–2 bags of fertilizer per acre. The other 80 percent of Masara outgrowers seem to be compliant—that is, they used the recommended amount of fertilizer and likely also for other inputs.

We ran several models to measure any loss in yield in the scheme plots due to fertilizer diversion by comparing yields in the scheme plots of compliant and noncompliant Masara outgrowers (Table 4.10, Models 1 and 2). We also modeled Masara outgrowers' possible diversion of fertilizer to their own nonscheme plots by checking for a significant difference in nonscheme plots' yields between compliant and noncompliant Masara outgrowers (Table 4.10, Models 3 and 4). Simple mean comparison tests (*t*-tests) show a significant difference in scheme plots' yields between compliant and noncompliant Masara outgrowers. These tests also show no difference in nonscheme plots' yields between compliant and noncompliant Masara outgrowers and in yields between nonscheme plots of Masara outgrowers and nonoutgrowers, indicating that the diverted fertilizer is likely not used on nonscheme plots in this sample but is probably used on other plots or sold to other farmers.

These simple *t*-tests are generally consistent with the regression models in Table 4.10. The yield difference between compliant and noncompliant scheme plots is 142 kg/acre. This is generally consistent with data shown in Table 4.9, in which 1 kg of nitrogen (N) (or 5 kg of fertilizer) can increase yield by 6–7 kg/acre. Because the diverted fertilizer usually amounts to 50–100 kg (1–2 bags), the possible yield loss is 60–140 kg/acre. However, using the quantity of N diverted in Model 2 (Table 4.10), the potential yield loss is 12–24 kg/acre. The range of possible yield loss, then, can be 12–142 kg/acre, which means that earlier estimates of the impact of CF schemes may be too low, and that more farmers may actually experience positive impacts. However, this range is still quite small and the number of noncompliant outgrowers makes up only 20 percent of all Masara outgrowers. Therefore, the underestimation of CF's impact on average across all maize growers is small and does not greatly change the estimates given earlier in this section, in Table 4.1: the estimated range of yield effects changes from 500–800 kg/acre to 505–820 kg/acre, and the estimated range of negative profits (losses) changes from GHS 180–240/acre to GHS 160–200/acre. There is slight underestimation in the magnitude of these effects, but the lack of profitability from CF schemes and their limitations as a pro-poor development strategy still hold.

[3] We only received reports on diversion of fertilizer and not other inputs, such as seeds or herbicide, to other plots or to other purposes.

Table 4.10 Regression models linking productivity effects of fertilizer diversion on outgrowers' scheme and nonscheme plots

	Scheme plots		Nonscheme plots of outgrowers	
Variable	Model 1	Model 2	Model 3	Model 4
Plot used all inputs received (yes = 1)	142.650***			
	(47.99)			
Nitrogen diverted from scheme plots (kg)		-1.186***		
		(0.45)		
Outgrower did not divert (yes = 1)			52.60	
			(58.86)	
Nitrogen diverted from scheme plots (kg)				-0.06
				(0.45)
Improved planting practice (yes = 1)	58.88	58.28	-58.93	-57.06
	(37.63)	(37.67)	(47.37)	(47.53)
Used tractor (yes = 1)	-593.652***	-583.788***	-136.78	-136.01
	(149.56)	(148.60)	(123.98)	(124.28)
Slash-and-burn practices (yes = 1)	18.16	17.72	-29.02	-22.62
	(45.17)	(45.11)	(59.30)	(58.94)
Pannar (yes = 1)	-46.59	-30.60	18.08	17.84
	(87.76)	(86.95)	(77.43)	(77.01)
Years under fallow	-8.78	-7.80	-10.86	-9.66
	(14.88)	(14.98)	(13.18)	(13.10)
Waterlogging is an issue (yes = 1)	64.17	63.67	27.93	26.37
	(59.58)	(59.51)	(74.32)	(75.17)
Erosion is an issue (yes = 1)	-79.07	-85.546*	122.59	120.71
	(50.09)	(49.69)	(89.30)	(88.93)
Not fertile (compared with fertile)	-97.021**	-97.447**	-41.58	-41.37
	(39.31)	(39.48)	(46.05)	(45.93)
Very fertile (compared with fertile)	-98.07	-94.60	235.65	243.77
	(65.82)	(65.13)	(196.05)	(196.63)
Year 2015	11.57	4.77	38.68	36.83
	(37.46)	(37.75)	(45.50)	(45.44)
Constant	-21,571.45	-7,768.30	-77,079.03	-73,310.27
	(75,476.32)	(76,078.97)	(91,642.01)	(91,520.14)
N	608	608	427	427
R-squared	0.08	0.08	0.03	0.03

Source: Raw data from IFPRI and ISSER (2016).
Note: Significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

How Can These Schemes Have Positive Impacts?

CF schemes facilitate access to inputs and information on improved management practices, which are hard to find in remote, underdeveloped areas, such as the Upper West region of Ghana. And because of these technologies, productivity has increased. However, in terms of profitability, repayment is too high for most participating farmers. This high repayment cost means either that firms are the ones getting much of the profits or benefits from CF, or that the repayment cost is merely fair compensation for the various risks firms face, including repayment defaults. In the key informant interviews, a CF scheme representative pointed out that firms' high administrative and logistical costs drive the substantially high repayment requirements.

Based on information on prices, input provision, and required repayments reported by scheme operators or aggregators, we computed for input costs and imputed interest rate for these inputs. On average, Masara or Makati outgrowers "borrow" GHS 510–770/acre worth of inputs, if we value the inputs using average market prices (see Table 2.1), and they have to pay back GHS 810–1,100/acre4 after five to six months during harvest season. This is roughly a 29-59 percent nominal interest rate payable after six months. Across all schemes, outgrowers "borrow" GHS 500/acre of inputs, and they have to pay back GHS 820/acre of maize grains on average (see Table 2.1). This is roughly 67 percent nominal interest rate after five to six months. An issue in the above calculations is the different prices of inputs and maize that are being reported by scheme operators to compute for costs and repayments, in which at times, these prices are different from those we got as common or average in those villages from the survey. This may reflect shadow prices, which are different from market prices, faced by farmers especially in remote areas (such as UWR), or it may just be a reflection of monopolistic behavior by aggregators/scheme operators (in which they can dictate any price of inputs). Nonetheless, we conducted the calculations with the available data and reasonable assumptions.

The compounded interest rate is roughly 6.2 percent monthly, on average across all schemes. The annual effective interest rate is roughly 115 percent on average across all schemes. Again, this estimate is on average; there is some variability across households. These averages are similar for both the Masara and Akate schemes; both have similar input provisions and required repayments. This rate is much higher than the 18–25 percent interest rate per year charged on loans provided by agricultural development banks or other banks or microfinance institutions (Nimoh, Tham-Agyekum, and Awuku 2013; Thompson 2015). Despite their lower interest rates, loans from these other sources are not highly accessible. The cumbersome loan-making process, coupled with delays that often keep loan proceeds from being available at the time they are needed for production, prevents many farmers from applying for and using credit from formal sources (Nimoh, Tham-Agyekum, and Awuku 2013; Thompson 2015). Moreover, the valuation of loan security and the associated documentation constrains farmers' desire to apply for and use formal credit (Nimoh, Tham-Agyekum, and Awuku 2013; Thompson 2015).

Two scenarios may help with the productivity and profitability of CF schemes. First, if the required repayment is too high and the imputed prices of inputs are much higher than their market prices, setting a lower repayment requirement, or cost of credit, may help. Second, if the yield improvements due to increased access to inputs and technologies are not high enough to compensate for the high cost of accessing these goods under a scheme, how would profitability be affected if higher-yielding varieties and much-improved technologies were developed and promoted as part of CF schemes? We simulate these scenarios, and the results are shown in Table 4.11.

Using market prices to value the inputs provided on credit would have positive and significant impacts on scheme participation. Masara scheme farmers would have an average increase in profits of GHS 47, which is still minimal but would enable positive and higher profits for many more households than the current arrangement. Using market prices and applying an interest rate of 25 percent for six months, despite having a negative impact on profits on average, would still yield positive profits for a greater number of households than the status quo. This simulation shows, however, that high repayment requirements may not be much of an issue and reducing repayments may not provide high enough profits to change the economics of CF schemes.

If yields are increased by 50 percent, which is possible with the officially released Pioneer 30Y87 varieties, and if we assume that only scheme participants have access to the high-yielding seeds, the positive impact of scheme participation on profits would be high. If we assume that the new varieties would also be available to nonscheme growers—for example, that current modern variety adopters would have access to the new variety and would increase their yields by 50 percent—the impact of scheme participation on profitability would be positive and significant (GHS 72/acre) on average, even at the

[4] Based on IFPRI and ISSER survey (2016), required repayment under Masara and Akate schemes for fertilizer, seeds, herbicide, and materials received under a scheme is on average 21–25 50-kg bags of shelled maize grain per acre, valued at GHS 45/bag as the average market price for maize grain. For other schemes, it varies.

current high cost of credit. If yields are increased further, say to 100 percent, the impact on profits would be high and more farmers would benefit from scheme participation. Compared with reducing repayment requirements, it seems that a greater impact can be achieved through improvements in technologies and yields.

Figure 4.2 compares the yield and cost of maize production in Ghana with that of other African countries and major maize-exporting countries—the United States, Brazil, and Argentina. Panel (a) shows that the cost of production per hectare is much higher in Ghana than in some of the African countries and exporting countries. Excluding family labor, however, whose opportunity cost is challenging to compute, the cost of production per hectare in Ghana is not substantially higher than in other countries. On the other hand, when we look closely at the cost of producing 1 ton of maize, shown in Panel (b), the figures for Ghana are substantially higher. Excluding family labor, the cost of producing 1 ton of maize in Ghana is about twice that of other African countries, and seven times higher than that of the United States, Argentina, and Brazil. Taking both panels of Figure 4.2 into consideration, it is not apparent that the difference across countries is due to inputs applied or their unit costs; instead, the huge difference seems to be in maize productivity. Ghana's national average is 1.7 tons/hectare, and figures derived from farm surveys are even much lower. Eastern and southern African countries produce 2.2 to 4.5 tons/hectare on average, except Mozambique, while the United States, Brazil, and Argentina produce 6.0 to 10.0 tons/hectare on average. Although CF schemes and the technologies being promoted through them increase yield, the increase is not high enough to compensate for the higher input requirements and the cost of capital. This situation is clearly illustrated in Figure 4.3, which shows that the cost of producing 1 ton of maize is even higher under a CF scheme than without CF. Both labor costs (family and hired) and "other" costs per ton of maize are much lower under CF, but fertilizer, seed, and herbicide costs are substantially higher.

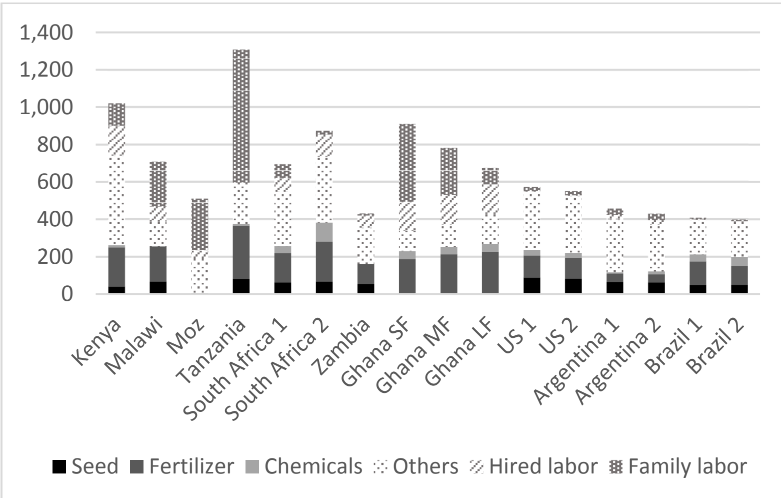
Table 4.11 Simulation results assuming lower repayment and increased yield effects of existing technologies promoted in schemes

Scheme comparisons	IPTW (base)		Using market prices for inputs provided under scheme		Using market prices + 25% interest rate after 6 months		50% yield increase (under scheme only)		50% yield increase (modern variety adopters only)	
	ATT	SE	ATT	SE	ATT	SE	ATT	SE	ATT	SE
All schemes versus no scheme	-245.97***	15.49	38.56**	16.29	-51.37***	16.36	289.70***	21.17	72.53***	22.83
Masara versus no scheme	-253.91***	17.80	47.01**	18.65	-50.30***	18.74	304.79***	24.83	87.86***	26.45
Akate versus no scheme	-305.89***	30.45	-33.21	35.80	-137.54***	37.56	226.73***	43.63	8.92	44.29
Other scheme versus no scheme	-351.78***	45.26	3.75	66.15	-20.33	58.77	38.85	88.14	-211.69**	83.56
Masara versus Akate	51.98	32.67	80.22**	38.01	87.24**	39.63	78.06	48.41	78.93	48.32
Masara versus other scheme	97.86**	46.72	43.26	67.42	-29.96	60.24	265.94***	90.68	299.54***	85.58
Akate versus other scheme	45.88	52.64	-36.96	73.89	-117.20*	68.33	187.88*	97.25	220.61**	92.70

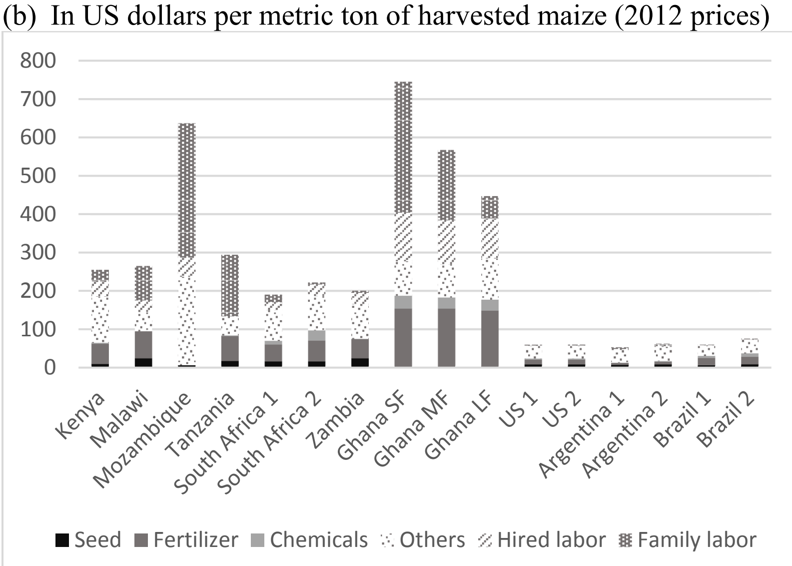
Source: Raw data from IFPRI and ISSER (2016).
Note: Significant at * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. ATT = average treatment effect on the treated; IPTW = Inverse-probability-of-treatment weighting; SE = standard error.

Figure 4.2 Cost of maize production across selected countries

(a) In US dollars per hectare (2012 prices)



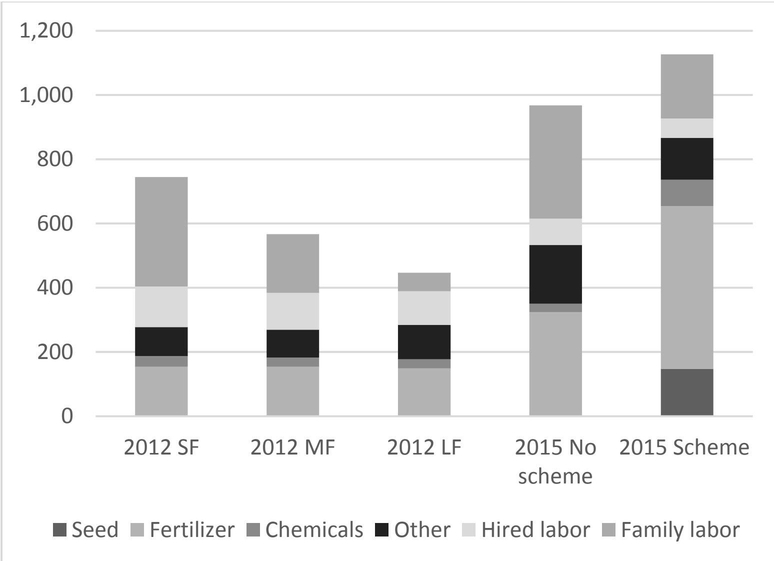
(b) In US dollars per metric ton of harvested maize (2012 prices)



Source: IFPRI and SARI (2013), and IFPRI and ISSER (2016) for data on Ghana; Meade and others (2016) for data on United States, Argentina, and Brazil; Jayne and colleagues (2013) for others. Data were also compared with World Bank (2009) comparative figures.

Note: Argentina 1 = northern heartland of Argentina; Argentina 2 = Argentina national average; Brazil 1 = Parana state; Brazil 2 = national average; Ghana LF = Ghana large farms; Ghana MF = Ghana medium farms; Ghana SF = Ghana small farms; South Africa 1 = typical farms using ZA1200NW; South Africa 2 = typical farms using ZA1600EFS; US 1 = United States heartland; US 2 = United States national average. "Others" mainly include opportunity cost of land, tractor hire including contractor and diesel, valuation of own machinery use, and irrigation fee.

Figure 4.3 Comparison of costs of producing 1 metric ton of maize between scheme and nonscheme maize farms, in Ghanaian cedis/ton



Source: 2012 = raw data for 2012 cropping season from IFPRI and SARI (2013); 2015 = raw data for 2015 cropping season from IFPRI and ISSER (2016).
Note: LF = average large farm; MF = average medium farm; No scheme = average nonscheme plot in Upper West; Scheme = average Masara/Akate scheme plot in Upper West; SF = average small farm in Northern, Upper West, Upper East, and Brong-Ahafo. The 2012 figures are adjusted to constant 2015 prices.

5. CONCLUSIONS

This paper looks at a unique plot-level dataset covering various maize CF or outgrower schemes in the Upper West region of Ghana. Evidence presented in this paper shows that these schemes contribute to technology adoption and productivity growth, but not to profitability, and therefore the results suggest limited ability of these CF arrangements to increase incomes and reduce poverty. Productivity increases from the improved inputs and management practices are not high enough to cover the high repayments required for the inputs provided on credit under the schemes.

There are some differences across CF schemes. The Masara and Akate schemes are similar, and their impacts and the magnitude of these impacts are also very similar; however, there seem to be different factors predicting farmers' participation in these two schemes and differences in the predictors of achieving higher yields and profits within these schemes. Moreover, other schemes that are smaller and more flexible tend to have less impact on technology adoption and yield, but at the same time have smaller required repayments or less costly credit, and therefore their net effect on profit is similar to that of the Masara and Akate schemes.

This paper rigorously models the impact of CF schemes, employing matching techniques and an IV approach to address unobserved heterogeneity across plots and farmers. However, the study has some limitations. First, the impact of CF schemes is estimated on the scheme plots and scheme households compared with matched control groups; spillover effects are not calculated. For example, the impacts on other maize plots and other crops due to possible spillover of knowledge on improved management practices or diversion of inputs received from scheme to nonscheme plots within households and across households are not estimated and are areas for future research. Second, the effect of CF schemes on the dynamics of labor and land use, on prices, and on contributions to rural employment, crop diversification, and food security are not estimated and are suggested as topics for future research. Last, firm-level perspectives are limited in this paper, and the components and magnitude of costs and gross margins of operating CF schemes were not collected due to the difficulty of accessing this information; this, too, can be a topic for future research.

Nevertheless, this paper shows evidence that CF schemes are not always a win-win strategy, as illustrated by the Ghana maize example in this paper. Evidence shows the challenges of these arrangements in increasing the profitability of value chains, and thus their limitations as a pro-poor strategy. Participants can exit these schemes if the benefits exceed the costs and risks of participation. Firms leading these schemes claim that required repayments are set high to compensate for the operating and monitoring costs of running the scheme as well as the risks of loan default. Minimizing the costs of running and monitoring the schemes may enable firms to lower the cost of credit a bit. At the same time, and more important, developing and promoting higher-yielding varieties and further improved technologies will be necessary for CF schemes to contribute to increasing yields and incomes for a greater number of maize farmers.

APPENDIX: ADDITIONAL RESULTS

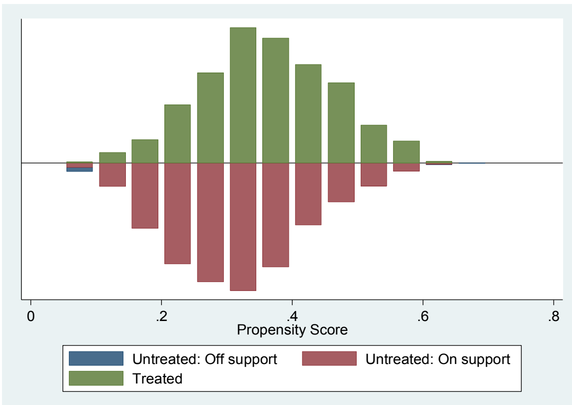
Table A.1 Multinomial probit for plot-level participation in maize outgrower schemes

Variable	Masara	Akate	Other schemes
Female head (yes = 1)	-0.086***	0.026*	-0.012
	(0.030)	(0.015)	(0.011)
Years of formal education of head	-0.007***	0.000	-0.001
	(0.003)	(0.001)	(0.001)
Head can read and write (yes = 1)	0.056*	0.029*	0.003
	(0.033)	(0.018)	(0.013)
Age of head (years)	0.000	-0.002***	0.000
	(0.001)	(0.001)	(0.000)
Members hold political or traditional office	0.011	0.004	0.005
(yes = 1)	(0.016)	(0.009)	(0.006)
Number of adults in household	-0.002	0.006**	-0.001
	(0.005)	(0.003)	(0.002)
Anyone in HH is member of association (yes = 1)	-0.032*	-0.010	0.003
	(0.018)	(0.010)	(0.007)
Frequency of head's listening to radio[a]	-0.026***	-0.008*	0.003
	(0.009)	(0.005)	(0.003)
Frequency of head's going to town[a]	-0.015	-0.016**	0.004
	(0.014)	(0.008)	(0.005)
Frequency of head's using phone[a]	-0.040***	0.019***	-0.006*
	(0.009)	(0.005)	(0.004)
Total livestock units (2010)	-0.005**	0.000	0.000
	(0.002)	(0.002)	(0.001)
Household assets index (2010)	0.034	0.004	-0.007
	(0.023)	(0.013)	(0.011)
Nonfarm income (dummy)	0.085***	0.018**	-0.022***
	(0.015)	(0.008)	(0.006)
Total agricultural landholdings (acres) (2010)	0.003**	0.002***	-0.001
	(0.001)	(0.001)	(0.001)
Community has agricultural project (yes = 1)	-0.036***	-0.019***	0.002
	(0.007)	(0.005)	(0.003)
Community has electricity (yes = 1)	-0.038**	-0.050***	-0.019***
	(0.017)	(0.009)	(0.007)
Distance to nearest input dealer (km)	0.001***	0.000	-0.0003**
	(0.000)	(0.000)	(0.000)
Distance to nearest road (km)	-0.019***	0.001*	-0.002
	(0.003)	(0.001)	(0.001)
Waterlogging is a problem in the plot (yes = 1)	0.028	-0.035**	0.026
	(0.025)	(0.016)	(0.008)
Erosion is a problem in the plot (yes = 1)	-0.009	0.019	-0.010
	(0.023)	(0.013)	(0.009)
Plot is not fertile (yes = 1)	-0.013	-0.029***	0.008
	(0.015)	(0.009)	(0.006)
Constant	-0.056	-0.586*	-1.370***
	(0.230)	(0.336)	(0.433)
N			*3,394.000*
Log likelihood			*-2,726.675*
Chi-squared			*390.539*

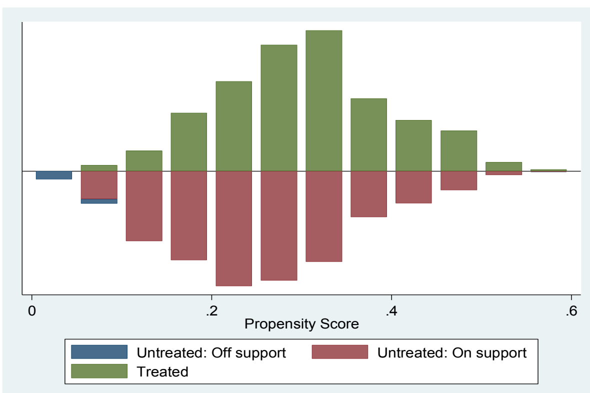
Source: Raw data from IFPRI and ISSER (2016).
Note: Figures are the marginal effects, computed from the multinomial probit model. Standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. a Likert scale from 1 to 5, 1 = most frequent. Different models were estimated using different indicators. For example, we used dummy variables instead of Likert scales for frequency of head's listening to radio and other indicators; we also used other asset indicators such as total landholdings, soil type, soil nutrients, rainfall level and variations, and other community-level characteristics. Year and district dummies are included in the regressions.

Figure A.1 Propensity score distribution and common support for those under outgrower scheme and those with no scheme

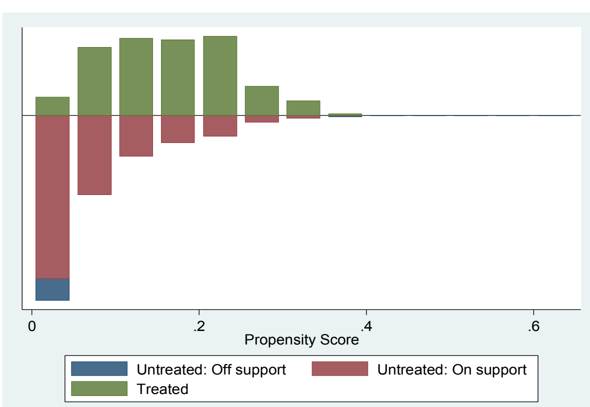
(a) With and without scheme



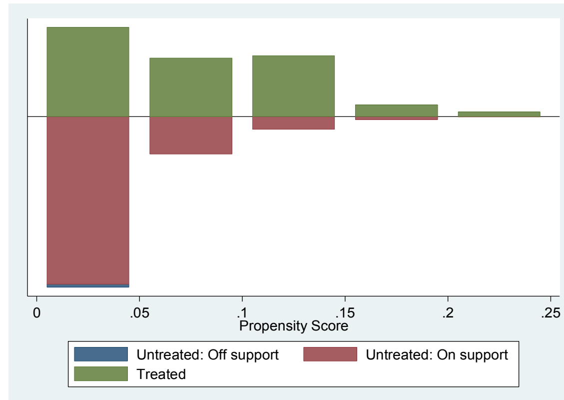
(b) Masara versus no scheme



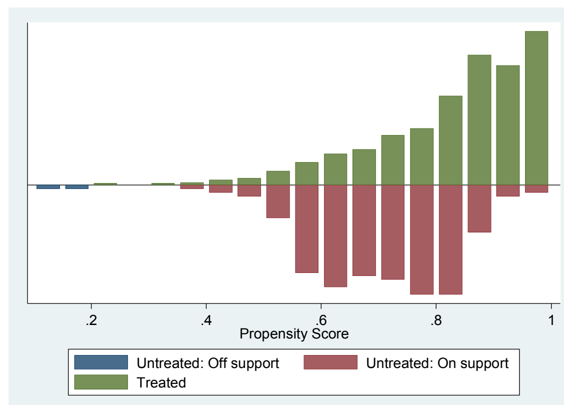
(c) Akate versus no scheme



(d) Other scheme and no scheme



(e) Masara versus Akate



(f) Masara versus other scheme

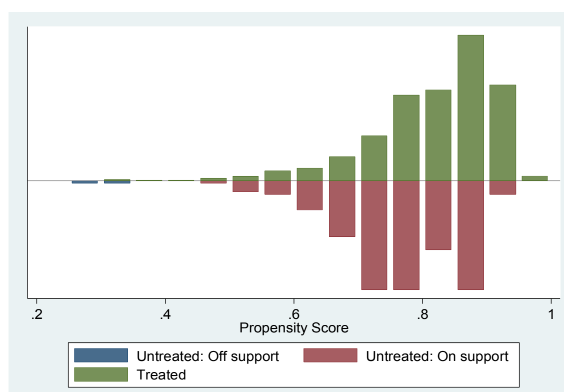
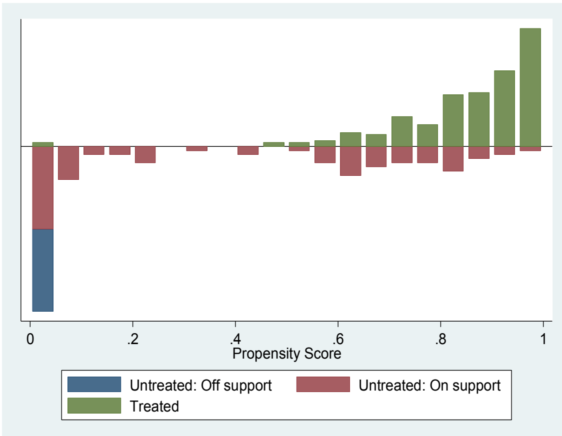


Figure A.1 Continued

(g) Akate versus other scheme



Source: Raw data from IFPRI/ISSER survey (2016).

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