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# Inventory Credit to Enhance Food Security in Africa

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CEE-M Working Paper 2019-03

# Inventory Credit to Enhance Food Security in Africa

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## Abstract

In many African countries, rural households typically sell their output immediately after harvest and then have to face the lean season in often dramatic conditions. This paper explores whether alleviating both credit and storage constraints through an inventory credit (or warrantage) program in Burkina Faso is associated with improvements in household food insecurity and dietary diversity. We partnered with a rural bank and a nation-wide organization of farmers to evaluate a warrantage system with seventeen villages in the western region of Burkina Faso. In randomly chosen treatment villages, the households were offered a loan in exchange for storing a portion of their harvest as a physical guarantee in one of the newly-built warehouses of the project. We show that, after three seasons, the warrantage program has extended users' self-subsistence period by an average of seventeen days, increased the average size of the farm by one and a half hectares (one additional hectare of cotton and one additional half hectare of maize) and increased dietary diversity significantly, with more fish, fruit and oil consumed weekly.

Keywords: inventory credit, warrantage, intertemporal price fluctuations, storage, savings.

JEL codes: O12, O13, O16, D14, E21.

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# 1 Introduction

The lean season, defined as the period between the depletion of food stocks and the realization of the new harvest, is particularly crucial in dry-land Africa where agricultural production is rain-fed and where there is only one short rain season a year. During this period, rural households are often constrained to sell productive assets, to rely on food aid or gifts from relatives or to borrow at excessive rates from traders to satisfy basic consumption needs. During this period, many rural households enter into vicious circles of indebtedness and become unable to invest into agricultural production. Reducing the lean season is thus a particularly high stake in those countries.

Staple food prices in rural Africa are typically low in the immediate post-harvest period and high in the pre-harvest period. The reason why many smallholder farmers are unable to exploit this opportunity for inter-temporal arbitrage has puzzled economists for a long time (Burke *et al.*, 2018; Stephens and Barrett, 2011). One important reason might be that farmers do not store their grain because they lack access to credit or savings and thus have to sell their grain at low post-harvest prices to meet urgent cash needs like school fees (Dillon, 2017). Another reason might be that farmers do store their grain but lack a good storage technology that would allow them to store enough until the next crop, avoiding losses due to mold and pests (Kumar and Kalita, 2017), self-control problems (Ashraf *et al.*, 2006; Bauer *et al.*, 2012; Le Cotty *et al.*, 2018), social pressure to share with kin and neighbours (Platteau, 2000; Barr and Genicot, 2008; Baland *et al.*, 2011; di Falco and Bulte, 2011; Jakiela and Ozier, 2015; Goldberg, 2017), or all three at once (Aggarwal *et al.*, 2018).

Inventory credit (or warrantage) is likely to solve both the credit problem and the storage problem. With warrantage, banks typically offer farmers an advance amounting to 80 percent of the market value of the amount of grain that they elect to secure in a certified warehouse over a six-month period. The grain put as a collateral in those warehouses is stored in bags of high quality and treated against the pests and it is impossible, for the farmer as for the bank, to recover it before the maturity of the loan. Providing such device should thus help all types of constrained farmers: urgent cash need can be met through credit while part of the harvest is stored in a safe place for six months and returned to the farmer (who is able to repay the loan) when it is needed the most and prices are high. Warrantage is thus expected to allow its users to reduce the much-feared lean season. If grain prices have increased significantly during the six months, the farmer will have no difficulty in repaying the bank and will also end with enough money in hands to satisfy consumption needs until the next harvest. A variety of additional, possibly longer term, effects are expected, the importance of which is hard to guess beforehand. For example, participants in warrantage may invest the credit in activities generating income like purchasing fertilizers or hiring farm labor. They may also seek to improve their daily diet. We examine many of these potential effects in this paper.

We partnered with the Réseau des Caisses Populaires du Burkina Faso, a rural bank operating in Burkina Faso, and the Confédération Paysanne du Faso (CPF), a nation-wide organization

of farmers, to evaluate a warrantage system with seventeen villages in the western region of the country. In January 2013, we ran a baseline survey from a random sample of 933 farmers spread across these villages and randomly selected eight of them that were then provided a warehouse. In November 2013, each farmer living in a treatment village was offered credit in exchange for storing a portion of their harvest as collateral in one of the newly-built warehouses, with no opportunity to access the stored grain for a period of six months. We collected data on farmers' participation in the system in 2013 and again in 2015. We moreover collected another round of data from the same sample in August 2016, i.e. after three full agricultural seasons. The warrantage system continued to function in subsequent years.

Although participation in warrantage was quite high on average over the three seasons - starting with 16 percent in 2013 and then reaching 33 percent in 2015 -, we failed to detect significant effects of the program at the village level. On the contrary, we found significant impacts on the subset of farmers who actually used the device. Using various quasi-experimental estimators - including IV and DID-matching approaches - we found that the warrantage program had several effects among participants. First, we found that it has improved significantly farmers' access to sufficient food, by extending the self-subsistence period by an average of seventeen days and increasing the probability of having grain remaining in the granaries during the pre-harvest period. Second, we found that participating in warrantage also translated in an improved dietary diversity, namely, it has increased the probability to eat fish, fruit and oil daily or several times a week. Finally, participation in warrantage has significantly increased the total cultivated area, with one additional hectare of cotton and one additional half hectare of maize on average (on which fertilizer has been applied), as well as the cattle size (between one and two additional heads of cattle on average). All together, these results suggest that warrantage is likely to perform well in providing farmers with an opportunity to overcome the "sell low buy high" phenomenon, enabling them to adjust their selling activities throughout the year and taking advantage of seasonal crop price fluctuations.

Some recent empirical studies have already showed that releasing households' credit constraints can have important consequences for the improvement of the standard of living in developing countries (Stephens and Barrett, 2011; Basu and Wong, 2015; Fink *et al.*, 2014; Beaman *et al.*, 2014; Burke *et al.*, 2018). In a field experiment in Kenya, Burke *et al.* (2018) showed that providing timely access to credit allows farmers to buy at lower prices and sell at higher prices, increasing farm revenues and generating a return on investment of about 30 percent. Some other papers have stressed the importance of having a reliable storage technology that protects the grain from all possible "attacks", which includes both the impulses of the farmer himself and solidarity expenses. In a field experiment in Kenya, Aggarwal *et al.* (2018) showed that providing a communal saving scheme for maize significantly increases both the probability to store and the probability to sell later and at higher prices. Our study builds on and extends this literature by providing the

first field-based evidence that evaluates the impacts of removing both the credit constraint and the storage constraint through a warrantage system. Beyond the participation rate, the success of a warrantage system should also be measured through its impact on households' standard of living and food security. Our paper aims at quantifying these effects.

The article proceeds as follows. Section 2 describes the main features of the warrantage system that we implemented in Burkina Faso. Section 3 provides the empirical framework, which includes the data and the empirical strategy used to estimate the effects of the system. Section 5 presents the results and Section 6 concludes.

## **2 The FARMAF project**

Most of the information provided in this section can also be found in the companion paper “Inventory Credit as a Commitment Device to Save Grain until the Hunger Season” by Le Cotty *et al.* (2019).

### **2.1 Context**

Inventory credit - commonly named warrantage in French speaking developing countries - is not yet widespread in Africa. Formerly developed in Niger with FAO interventions in the 1990's, it has been introduced in Burkina Faso in 2005, with the help of development projects (Tabo *et al.*, 2011). The two oldest inventory credit systems, implemented in the south-west of Burkina Faso, are those of the Union TenTietaa and the cooperative Copsac. They benefited from the respective support of the Non-Governmental Organizations SOS-Sahel and CISV, and were inspired by older warrantage systems in Niger (Coulter and Onumah, 2002; Pender *et al.*, 2008), notably by the one led by the Union Cigaba de Konkorindo. Both farmers' organizations and rural banks have strongly appropriated inventory credit in the last ten years, and have contributed to the development of inventory credit in the country. Most of inventory credit experiences are located in surplus areas where grain production exceeds grain consumption, in the Western and South Western regions of the country, where farmers often produce maize and sorghum, and sometimes rice. New inventory credit experiences are emerging in deficit areas where farmers tend to store cash crops as sesame, cowpea and groundnut. To our knowledge, none of the projects mentioned above has been rigorously evaluated so far.

### **2.2 Implementation and operating principle**

As part of the FARMAF project, we implemented a warrantage system in two administrative districts of Burkina Faso, the Tuy and Mouhoun provinces, in the western region of the country (Figure 1). We partnered with the CPF, a nationwide farmers' organization, to shortlist villages that

were eligible to inventory credit in these two regions of the country. The selection was made on the basis of four criteria: i) the farmers' organization (FO) represented in the village had to be member of the CPF; ii) the FO had to be interested in taking part into the program (whether treated or not); iii) the village had to be less than 20 kilometers away from a rural bank agency of the Réseau des Caisses Populaires du Burkina; iv) the FO had to have an opened account at the rural bank, with no default payment situations. Seventeen villages were finally identified, eight of which were randomly assigned to receive the warrantage program, which includes the building of a warehouse and a number of training sessions. The random draw was made using a simple urn containing the names of the 17 villages, in the presence of representatives of the CPF.

During the year 2013, warehouses that could hold up to 80 tons of grain were constructed in each one of the treatment villages.<sup>1</sup> The FARMAF project covered 95 percent of the building cost, the remaining 5 percent were paid by the farmers. The warehouses were built in the villages so that farmers can bring their bags themselves with bicycles, motorcycles or donkey pulled carts. The warehouses are secured with two locks. The key to one of these locks belongs to the rural bank, and the other key belongs to the local farmers' organization. As a result of this dual-lock system, neither party can open the warehouse in the absence of the other. Warehouse control visits by representatives from both the FO and the rural bank take place every month.

In 2013 and throughout the three farming seasons that followed, the CPF organized a major training campaign in all treatment villages, which involved FO's representatives, rural banks' representatives and farmers. A total number of 64 training sessions were led, devoted to the description of the warrantage tool, in-depth discussions on specific issues such as control quality management, credit monitoring or collective marketing strategies. They also included testimonials from participants in programs implemented in the past. In each treatment village, a so-called inventory credit management committee (ICMC), made up of farmers responsible for the operation of the warrantage system, was elected. Members of those committees followed a collective training internship in Founzan, a village where farmers were already using a similar scheme. A large meeting bringing together the committees and representatives of the CPF of each village was organized in September 2013, just before storage. Another meeting was then held in rural bank offices to build trust between the farmers and the bank and to agree on a schedule of operations to be carried out between harvesting and warehouse lockdown. Finally, a meeting was led in each village after the reopening of the warehouse, in March 2014, in order to share problems and improve the procedure for next year.

The warrantage system is designed according to the agricultural calendar (Figure 2). Farmers are allowed to store cereals, sesame, and peanuts. Farmers store mainly maize, followed by

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<sup>1</sup>The warehouses have a storage capacity of up to 80 tons, which means, for example, that 50 households can each deposit 16 bags of 100 kg. In November 2015, i.e. after three seasons of warrantage, 85 percent of the storage capacity was reached.

sorghum and millet, which are characterized by very similar price patterns.<sup>2</sup> In Burkina Faso, land preparation and sowing for maize, sorghum and millet typically begin in June, and the crops grow during July and August, maturing between September and October.<sup>3</sup> Farmers who participate in the warrantage system deposit a portion of their harvest in one of these warehouses in exchange for a 6-month loan in November, which is often used to pay seasonal employees for cotton harvesting. Farmers who are able to repay the loan get their collateral back in May, at the lean season, when the price of grain is usually high.

The rural bank does not lend more than 80 percent of the value of the inventory at the time of the loan. Should borrowers default, this protects the rural bank even if the price of grain decreases by 20 percent – something that is very unlikely to occur. The monthly interest rate charged by the bank is around 1 percent. The value of the collateral is determined by the rural bank.<sup>4</sup> Farmers are also charged the cost of storage, which amounted to 100 CFA for each 100 kg bag of grain per month. This storage fee is based on information regarding previous warrantage programs that have been implemented in Burkina Faso and Niger. It includes the warehouse maintenance and the transaction costs incurred to deal with credit institutions (phone calls and travel from village to bank agencies). The borrower's name is written on each bag of grain that is deposited so that each farmer can identify his deposit thereafter. Farmers also have the opportunity to store grain without taking out a loan.

When the loan matures, in May, the bank demands repayment of the amount borrowed plus interest before authorizing the restitution of a farmer's collateral. If the farmer is not able to reimburse the loan and interests, the collateral is sold. In practice, the farmer must find a buyer and meet him at the warehouse on the repayment date. In this case, the farmer reimburses the bank and keeps what remains. If the farmer is unable to find a buyer on the repayment date, he is subject to a penalty: 10 percent of the total debt per day late. If the farmer defaults, the bank keeps the collateral. We do not have data on the proportion of farmers who had to sell their collateral in order to repay their loan. However, we do know that no farmer received penalties between 2013 and 2015.

Farmers must make a tradeoff between the benefits of participating in the warrantage system, such as access to credit and to a commitment device, and its direct and indirect costs, such as the opportunity cost of the collateral deposit, the obligation to pay storage costs at the time of

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<sup>2</sup>Farmers may also store beans (niébé), but since the pre-storage drying process is much easier for grains than for beans, farmers tend not to store beans. Another reason why farmers store mainly maize is that maize yields are higher (maize responds better to fertilizer). Sorghum and millet are very much appreciated for self-consumption and traditional usages including making dolo (a traditional beer), whereas maize is not only consumed but is also a cash crop. Cotton, the main cash crop, is not a possible candidate for warrantage, notably because a parastatal board controls the entire cotton sector.

<sup>3</sup>The length of the cropping cycle is around 100 days for maize and 120 days for millet and sorghum.

<sup>4</sup>In 2013, the interest rate was 0.7 percent in Magnimasso, 0.8 percent in Lopohin, 1 percent in Tankuy, 1.5 percent in Bouéré, and 1.2 percent in Bladi, Biforo, and Gombélé Dougou. The mean value of a 100 kg bag of maize or sorghum as collateral was 10,000 CFA.



deposit, the risk of not being able to reimburse the loan, the possible lack of understanding of how the system functions, the possible lack of trust. In this system, the total cost of credit can easily be offset by the rising value of the collateral, which was around 40 percent on average over the last decade according to price surveys made by the Afrique Verte association on local markets.<sup>5</sup> However, the warrantage system may not be the cheapest alternative for immediate liquidity when the increase in grain prices is small. Indeed, warrantage is profitable only when the increase in the price of grain is sufficiently large compared to the interest rate. For instance, consider a household that owns some grain with a value of 10,000F (post-harvest) and requires 8,000F for immediate consumption. With warrantage, it must store 10,000F as collateral in order to obtain a loan of 8,000F and will be required to reimburse about 8,500F after six months. If the price of grain does not increase over this time period, it will end up with 1,500F (10,000 – 8,500). Without warrantage, it can sell grain to obtain 8,000F immediately and store 2,000F at home, ending up with 2,000F six months later (continuing to consider the case in which the price of grain does not increase). In this case, selling on the market to get cash immediately is obviously more profitable than participating in an inventory credit system.

### **3 Data**

#### **3.1 Survey data**

During the project, we carried out two major surveys: a baseline survey in January 2013, approximately eight months before the first warrantage transaction, and a final survey in August 2016, at the end of the third farming year. In January 2013, 933 farmers were randomly surveyed in the seventeen villages: 681 of them were located in treatment villages and 252 in control villages. In treatment villages, we interviewed all CPF members, as well as a number of non-CPF members. We stratified the sample such that CPF members represented two-thirds of the total number of surveyed farmers. An average of 90 households were interviewed in each treatment village. A total number of 28 farmers was interviewed in each control village.

Twenty enumerators and two supervisors were recruited for the data collection. Surveys and experiments were conducted in the Dioula language. The enumerators interviewed the heads of households, who were defined as the person responsible for making the farming decisions of the household. Households were randomly selected following the “steps” method. The enumerators started their walk at the northernmost household in the village and then walked south east until the limit of the village, then continued south west until the opposite limit of the village, and so on until they have walked through the entire villages. If the village had 300 households and they aimed at surveying 30 households, they surveyed a household every ten households that they

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<sup>5</sup>Monthly local prices can be found at <http://www.afriqueverte.org/>

met on their way. The number of steps from the northernmost household and the first surveyed household is random. If a household-head was not there, they came back later.

We returned to the field in August 2016. Of the eight villages enrolled in the program in 2013, one village had decided to leave the program and not to participate in the 2015 follow-up survey. Moreover, additional attrition occurred due to migration, death, or enumerators' inability to physically find the household head, most often because this person has moved and changed his name, something frequent in case of religious conversion. At the end, our sample includes 770 farmers who were surveyed twice: 524 treated and 246 controls. The 2016 survey included the same questions as the 2013 survey, as well as additional questions related to food security, whether in terms of access to sufficient amount of food or in terms of diet diversity:<sup>6</sup> the quantity of maize, sorghum, and millet currently in granaries (in kilograms), a dummy taking on the value of one if the farmer states that he has still grain stored in his granaries (and zero otherwise), a dummy taking on the value of one if the farmer states that the quantity of grain currently stored in his granaries is large enough to "hold out" until the next harvest (and zero otherwise), the number of days of household self-sufficiency.<sup>7</sup> The 2016 survey also included questions about the food families consumed by the household. In the survey, farmers were asked "In the last seven days, how many times have you eaten the following foods?". For each food family, we constructed a dummy variable that takes on the value of one if the farmer answered "between 3 and 6 times", another one if the farmer answered "one time or never", and another one if the farmer answered "every days".

### 3.2 Sample characteristics

Table 1 reports mean values for various farmer characteristics collected during the baseline and final surveys. On average, the treatment households are comprised of 11 members, 6 of whom are employed in farming activities. In the Tuy and Mouhoun provinces, the main crops are cotton, maize, sorghum, and millet. On average, the surveyed households own 8 hectares of land (11 ha on average in the control group). They devote about 20 percent of their land to maize, 20 percent to sorghum, and about 40 percent to cotton. Basic statistics on main variables however suggest that attrition did not introduce important biases in the data (Table 2).

We compare our data with the nationally-representative agricultural survey carried out by the Ministry of Agriculture of Burkina Faso in 2013 (see Table 3). This survey includes 5,197 rural households that were randomly selected in each of the 45 provinces of Burkina Faso, among which 265 households were located in the Tuy and Mouhoun provinces, where our project was implemented. Table 3 shows that average household characteristics are very similar between our sample and the households from the same geographic area that were included in the national survey. This

<sup>6</sup>Questions about remaining grain in granaries, or dietary habits, had no place in the 2013 survey, since it took place in January, that is, long before the lean period.

<sup>7</sup>In the survey, the farmer was asked: "How many days do you think your current stock will allow you to satisfy the basic consumption needs of the household?"

suggests that, although we focused, to some extent, on CPF members for the study, our sample appears to be quite representative of households located in western Burkina Faso.

### **3.3 Participation in warrantage**

The number of participants in the system has been steadily increasing over the three seasons, reaching more than 30 percent in November 2015. Our sample includes 180 farmers who participated in 2015 – and possibly during previous years as well (Figure 3). As Table 4 shows, farmers electing to engage in warrantage stored a large portion of harvested crops – about 34 percent in 2015. Storage was comprised mainly of maize versus other staple food crops such as sorghum and millet. We find that the participants in the scheme are divided into three groups. In 2013, 67 participants (65 percent) borrowed 80 percent of the value of their stored harvest (the maximum amount allowed for a loan), 26 participants (25 percent) borrowed less, and the remaining 10 percent chose to store without taking out a loan. The situation was slightly different in 2015, as 77 participants (50 percent) borrowed less than the maximum amount allowed for a loan, and the proportion of those who chose to store without taking out a loan was also much higher (25 percent).

## **4 Empirical strategy**

We aim at estimating a number of possible effects of warrantage, which include economic decisions related to land management and food security. We first examine the impact of the program on households living in the villages where the program was implemented. Subsequently, we examine the impact of the program on households that actually used the warrantage scheme.

### **4.1 Parameters of interest**

We first aim to estimate the intention-to-treat (ITT) parameter. This analysis indeed includes every subject who is randomized according to the RCT, whether he is participant or not in the warrantage system. The ITT is defined as  $ITT = E(y^1 - y^0)$ , where  $y^1$  denotes the outcome level in the presence of the program and  $y^0$  denotes the outcome level in the absence of the program. In the absence of spillover effects within treatment villages, it can be difficult to detect an effect of the program at the aggregate level, all the more so as the participation rate is low and the effects of the program on the participants are small. In our case, however, there is reason to believe that warrantage was able to benefit other households than the households that actually used the device. First, farmers may have taken credit in their name for the purpose of sharing it with other households in informal arrangements. Typically, a farmer can store grain (and take credit in the process) on behalf of another farmer. This type of arrangement being informal, our data do not allow us to distinguish the “true” participants from the “false” ones. Second, participants who became wealthier thanks

to the warrantage system may have decided to benefit their kin and neighbours of some of their earnings, in the form of grain donations during the lean season typically.

We then aim to estimate the average treatment on the treated (ATT) parameter, that is, the impact of the program on those households who actually used the warrantage scheme in 2015 (and possibly during previous years as well), which includes not only those who got credit but also those who chose to store without taking out a loan. This impact is measured, for example, as the average quantity of grain still in stock at the lean season in participants' granaries as a result of the project. It can also be, for example, the cotton area on treated farms that is due to the program. To determine this grain quantity or cotton area, we need to calculate the difference between the outcome level as observed on participating farms in August 2016 and the outcome level that would have been observed in those farms at the same date, had they not been involved in warrantage. The ATT is defined as  $ATT = E(y^1 - y^0 | D = 1)$ , where  $y^1$  denotes the outcome level in the presence of the program,  $y^0$  denotes the outcome level in the absence of the program, and  $D$  is a dummy variable which takes on the value of one when the farmer participated in the program and zero otherwise. We use various approaches to estimate the outcome level in the unobserved state, namely  $E(y^0 | D = 1)$ .

## 4.2 Estimators

We get an estimate of the ITT parameter by running a simple ordinary least squares (OLS) regression of the outcome  $y$  on treatment  $D$ , controlling for a set of pre-treatment covariates in case some imbalances remain despite the randomization procedure. In order to get an estimate of the ATT parameter, we then have to turn to quasi-experimental approaches, both more tedious to implement and based on stronger hypotheses. The main concern when evaluating the effects of warrantage on participants arises from the fact that the participants in treatment communities self-selected into the program given its voluntary nature. To deal with this issue, we use the instrumental variable (IV) approach and the difference-in-difference (DID) matching approach.

In order to recover the ATT, we apply the IV estimator using the random allocation of the warrantage program as an instrument. Note that in our setting where the only farmers who take the treatment (i.e. those who actually use the warrantage device) are those who were randomly assigned to treated (i.e. they are offered access to the warrantage scheme), the IV estimator gives the ATT (Imbens and Rubin, 2015). We also use two DID-matching estimators. We use the 2-nearest-neighbour matching estimator, which matches each participant to the two closest untreated farmers from the control villages, according to the vector  $X$ , and a propensity score method called inverse probability weighting (IPW) (Cattaneo, 2010). Matching eliminates selection bias due to observable factors  $X$  by comparing treated farmers to observationally identical untreated ones (Imbens, 2004). The DID-matching estimator moreover allows for temporally invariant differences in outcomes between participants and their  $X$ -matched counterparts from the control villages.

Applied to our data, this identification strategy consists of comparing the change in participants' outcomes between 2013 and 2016 with the change in outcomes among matched untreated farmers. We compute robust standard errors for matching estimators in a standard way. We moreover run a standard OLS regression with robust standard-errors adjusted for village clusters.<sup>8</sup>

In addition to the parallel trend assumption, DID-matching requires a selection on observables assumption (Heckman and Robb, 1985), which says that the dependence between treatment assignment and treatment-specific outcomes can be entirely removed by conditioning on observable variables. A crucial step to this end is thus to measure all factors  $X$  that are likely to drive both the decision to participate in the program as well as decisions regarding the land use and food security.

It is important that the observable factors  $X$  are not affected by the project (Imbens, 2004), which is why we use pre-treatment values from the baseline survey. We include in the set of observable factors  $X$ : the total land area (in hectares), the cotton area (in hectares), the maize area (in hectares), the sorghum area (in hectares), the amount of fertilizer used for maize (in kilograms), whether the farmer received a formal education or not, whether he received a credit or not during the previous year, the number of cattle, plows, and poultry, as well as the size of the labour force (measured as the number of family members who are employed in farming activities).

Another key assumption for the validity of the DID-matching approach is that the treatment received by one farmer must not affect the outcome of another farmer. This assumption is referred to as the Stable-Unit-Treatment-Value-Assumption (Rubin, 1978). In our analysis, the validity of this assumption is not likely to be threatened because the connection between villages is extremely limited due to the poor quality of transportation infrastructure. In addition, in the event that an individual from a control village requests permission to participate in the proposed scheme in the nearest treated village, he or she would be refused by the committee.

## 5 Results of the impact evaluation

### 5.1 ITT analysis

We first look at the impact of the treatment on a variety of outcomes for which we have collected data both in 2013 and 2016 - which allows us to apply the fixed-effect estimator. These outcomes include the total land area (in hectares), the cotton area (in hectares), the maize area (in hectares), the sorghum area (in hectares), the amount of fertilizer used for maize (in kilograms), the number of cattle, plows, poultry, and sheeps. Table 5 displays the results of a linear model that links the outcome and a dummy taking on the value of one when the farmer lives in a treatment village (and zero otherwise), as well as a variety of control variables (see Section 4.2). We do not find

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<sup>8</sup>In addition to the assumption of linearity, using this estimator requires supposing that the impact of warrantage is the same for all participants.

evidence that living in a treatment village affected farmers' land use decisions at standard levels of significance.

We then look at the impact of the treatment on a variety of outcomes for which we have collected data during the lean season of 2016 (August). Table 6 displays the results; they show no evidence that living in a treatment village affected farmers' food security at standard levels of significance. These results indicate that the treatment had no effect on the villages in which it was allocated or that the effects, if any, are too small (and/or concern a too small number of farmers) to be highlighted in our data. In what follow, we thus examine the likely effects of the program amongst participants.

## 5.2 Project enrollment

The program was offered to all households living in treatment villages (including non-CPF members). Farmers were invited to participate in information meetings and they decided to participate or not. This self-selection process might have led to a particular profile of participants, which distinguishes them from those who have chosen to never participate in the scheme, whether in 2013, 2014 or 2015 (Le Cotty *et al.*, 2018). We thus start our analysis by comparing participating and non-participating households living in treatment villages (Figure 3). Table 7 shows that the subset of surveyed farmers who decided to participate in warrantage in 2015 differ in some respects from farmers who never participated in the scheme. In particular, we find that participants have larger cotton areas and larger farms in general. They also have a higher probability to be literate and have larger families. These features play a central role in the matching procedure that follows.

## 5.3 Impacts on participants

### Matching procedure

To estimate the ATT, we apply the aforementioned estimators to the group of participants using those who were not offered the warrantage program to estimate the counterfactual level of land use outcomes (see Figure 3). This requires computing conditional probabilities for being enrolled in the program (or propensity scores)<sup>9</sup> and determining whether the matching procedure performed well. Table 8 compares the extent of balancing between the participant and control groups before and after the matching procedure. All normalized differences are well below the suggested

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<sup>9</sup>We compute propensity scores for participants and controls by estimating a probit model, using the sample of participants and never-participants living in treatment villages (see Section 5.2), where the dependent variable is a dummy which takes on the value of one if the farmer is participant (and zero otherwise) and which includes all of the aforementioned pretreatment covariates presented in Table 7. From the estimated parameters of this model, we then compute the conditional probabilities for participating in the program for both participants and controls. Figure 4 shows that densities in both groups are high enough for a wide range of propensity scores, meaning that the matching procedure is likely to perform well.

rule of thumb of 0.25 standard deviations (Rubin, 2001; Imbens and Wooldridge, 2009), which indicates that the matching procedure was successful in constructing a valid control group.

### **Land use and animals**

Our estimates of the effects of warrantage on agricultural decisions among participants are presented in Table 9. Column (1) gives the mean value of the outcome in 2016 amongst participants on the common support, while Columns (2)-(5) provide the impact of warrantage, that is, the difference between the value given in Column (1) and the estimated counterfactual level. For many outcomes, the impact is estimated with precision. Using the smallest significant estimator, the impact on the total land area is 1 ha, which suggest that using the warrantage system in 2015 (and possibly also the years before) encouraged the farmers to cultivate more land. Looking in more details at land use, one can observe that such impact on farmland is mainly due to an increase in cotton area. This result is in line with qualitative information collected in the field, which indicates that many participants chose to use their loan to hire farm workers to harvest more cotton. The results also suggest that warrantage also increased the maize area (as well as the quantity of fertilizer used for maize), albeit more slightly (less than half a hectare).

Interestingly, the results moreover suggest that warrantage encouraged farmers to invest in productive assets, which suggests that they used the loan (or the earnings generated through warrantage during previous seasons) to buy cattle and sheep. This makes sense since savings by agricultural households in developing countries frequently takes the form of productive assets that are also used on the farm. Typically, livestock can play two roles: a buffer for consumption smoothing and an income generator. This first series of results suggests two types of effects generated by warrantage (whether a loan with storage or storage alone): an increase in investment in factors of production (labor and land) whose returns will come as soon as the next harvest, and an increase in investment in productive assets that also have a safety net role.

### **Food security**

Table 10 displays the estimates of warrantage impact on various food security variables, using the IV estimator, the matching estimator, and the OLS estimator. Again Column (1) gives the mean value of the outcome in 2016 amongst participants on the common support, while Columns (2)-(5) provide the impact of warrantage, that is, the difference between the value given in Column (1) and the estimated counterfactual level. Matching estimators produce statistically significant results for four outcomes: the probability of having grain in stock at the time of the survey (+6 percentage points, taking the lowest estimate), the probability that the quantity of grain in stock is sufficient to satisfy basic consumption needs until the next harvest (+7 percentage points, taking the lowest estimator), the quantity of maize in stock (almost 200 kilograms, taking the lowest estimate), and finally the number of days of self-sufficiency (about 17 additional days). However, we are able to

provide significant results (at standard levels of significance) using the IV estimator for only one of these outcomes – the number of days of self-sufficiency. The mean value of the outcome among participants is 95 days and our estimates suggest that it would have been 78 days (95 – 17) in the absence of warrantage. These 17 additional days thus represent an increase of about 22 percent ( $17/78 = 22$ ).

We then look at the food families consumed by the household in a week. Table 11 displays the results of warrantage impact for the two outcomes for which we obtained statistically significant results, namely the probability to consumed the food several times a week and the probability to consume the food daily. Results show that warrantage increased significantly the probability to consume fish (+13 percentage points), oil (+9 percentage points), and fruits (+3 percentage points) several times a week. They moreover show a significant increase in the probability to consume fruits (+2 percentage points) and condiments (+9 percentage points) daily.

## 6 Conclusion

Inventory credit systems have been celebrated for giving farmers access to credit and, in doing so, providing them with an opportunity to overcome the “sell low buy high” phenomenon, notably because providing access to credit enables farmers to adjust their selling activities throughout the year and take advantage of seasonal price fluctuations. In this paper, we quantified the effects of one of the first warrantage system implemented in Burkina Faso. Our results suggest that such system is likely to generate strong effects among participants. In particular, we show that warrantage is likely to increase investment in factors of production (labor and land) and in productive assets that also have a safety net role (cattle and sheep). We further provide evidence that warrantage allows the improve self-sufficiency by more than 20 percent and even improve diet diversity to some extent (more fish, fruits, oil and condiments).

The warrantage system that was implemented in 2013 continues to function today. It should be noted, however, that the long term on-the-ground presence of the project proponent - the CPF - and the trust that characterized the relationship between farmers, the CPF and the rural bank in the study areas probably contributed to such encouraging results. In a less favorable context, many households may have been reluctant to entrust their grain to a farmer organization. It must also be recognized that the efficiency of the system can be significantly reduced when the state intervenes in the marketplace via price stabilization, as occurred in 2013.

We however failed to provide evidence of spillover effects within villages. Moreover, we are not able to show which of the two features of the system (access to credit or access to storage or a combination of both) has led to these effects.



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## 7 Figures and Tables

Figure 1: Location of participant villages

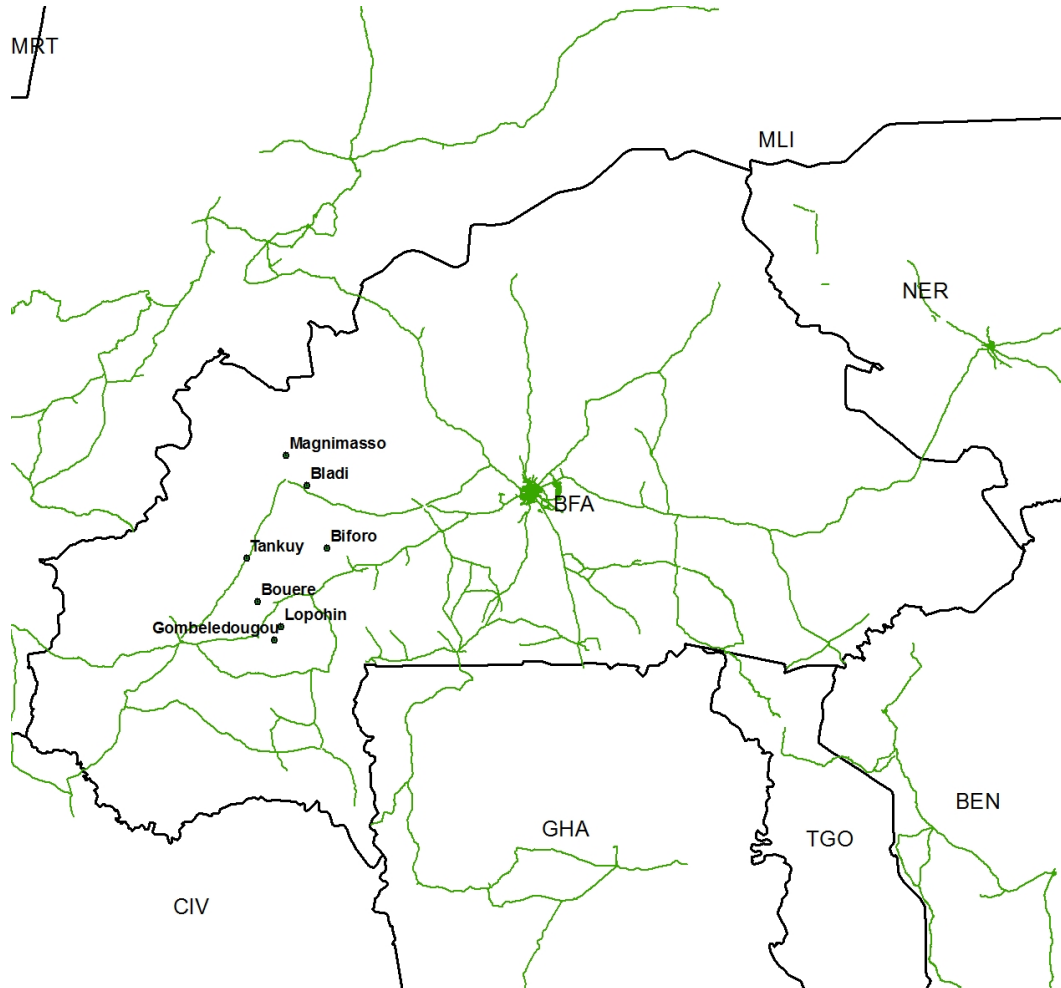


Figure 2: Agricultural Activities and Warrantage Calendar

	June	July	August	Sept	Oct	Nov	Dec	January to April	May
Grain production	Tilling	Sowing Fertilizing	Plant growing Weeding Fertilizing		Harvesting				
Cotton production	Tilling	Sowing Fertilizing	Plant growing Weeding Fertilizing			Harvesting			
Inventory Credit (or warrantage)						Storage Credit delivery		Credit repayment Collateral restitution	

Notes: Grain production refers to production of maize, millet and sorghum.

Figure 3: Sample composition

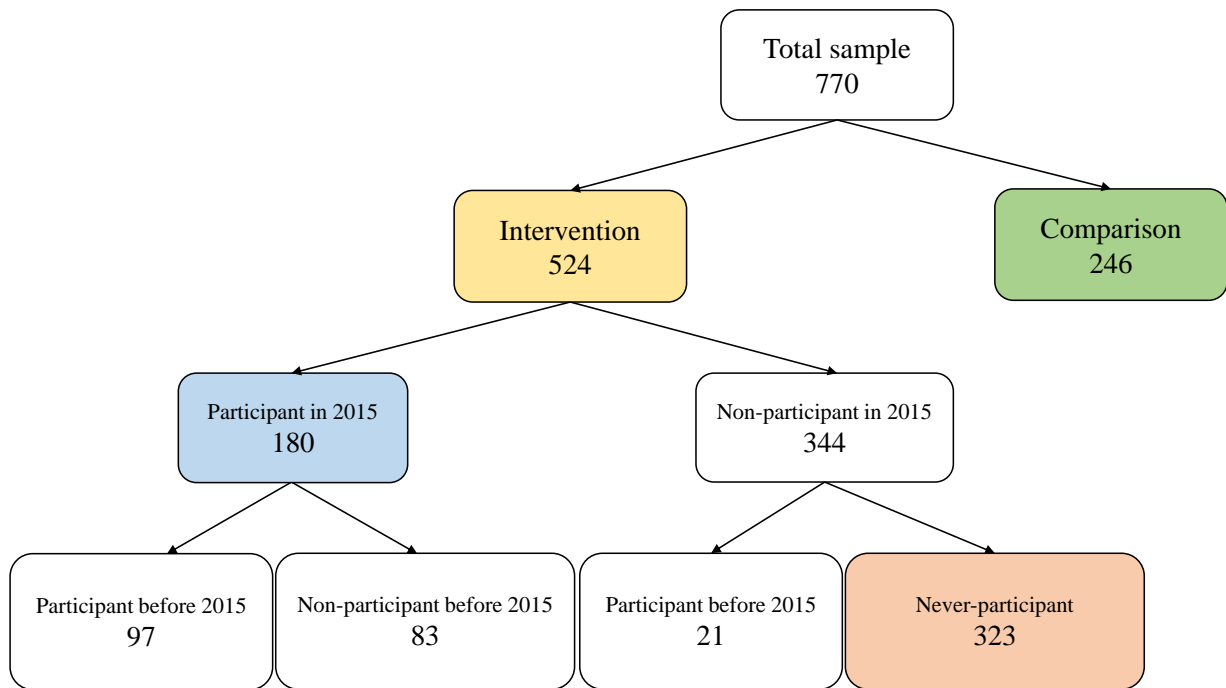
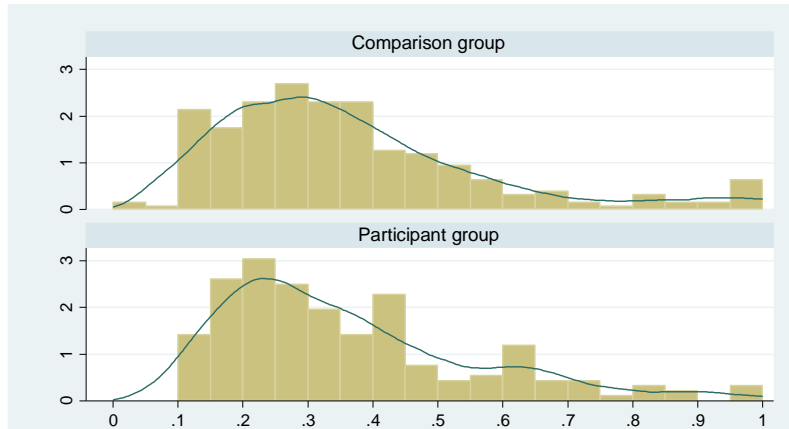


Figure 4: Distribution of propensity scores by groups



Note: The participant groups includes the 180 households that actually used the warrantage scheme. The comparison group includes the 246 households that were not offered to participate in the program.

Table 1: Household characteristics (Baseline survey)

Variables	Intervention group			Comparison group		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Literate (yes=1)	524	0.35	0.48	246	0.45	0.50
Family size (number)	524	11.25	7.68	246	13.89	10.20
Ploughs (number)	524	1.76	1.46	246	2.20	1.76
Labor force (number)	524	6.16	4.48	246	8.12	6.34
All cattle (number)	524	5.53	20.70	246	7.76	12.49
Draft cattle (number)	524	1.89	2.08	246	2.59	2.27
Poultry (number)	524	17.10	21.71	246	25.92	35.54
Sheep (number)	524	3.41	7.02	246	4.53	6.59
Fertilizer use (kg)	524	594.1	705.5	246	914.3	1081.7
Credit (yes=1)	524	0.63	0.48	246	0.69	0.46
Total land area (ha)	524	8.35	6.34	246	10.92	9.24
Cotton area (ha)	524	3.05	3.35	246	4.34	4.60
Maize area (ha)	524	1.74	2.66	246	2.27	3.07
Sorghum area (ha)	524	1.76	1.78	246	2.07	2.94
Cotton harvest (kg)	521	3475.7	9467.0	245	4376.9	4948.7
Maize harvest (kg)	520	2890.4	5196.6	246	3867.5	6654.6
Sorghum harvest (kg)	523	1313.3	1826.9	246	1378.5	1656.6

Note: Intervention group refers to the households living in the villages where the warehouses were built in 2013. Comparison group refers to the households living in the villages that were not offered to participate in the project.



Table 2: Survey attrition and household characteristics

	Initial sample (N=933)						Final sample (N=770)					
	Controls			Treated			Controls			Treated		
	Obs	Mean	SD.	Obs	Mean	SD.	Obs	Mean	SD	Obs	Mean	SD
Baseline survey	252	9.5	8.6	681	7.2	5.8	246	9.4	8.5	524	7.4	5.9
Total land area (ha)	252	4.3	4.6	681	3.1	3.4	246	4.3	4.6	524	3	3.4
Cotton area (ha)	252	2.3	3.1	681	1.5	2.4	246	2.3	3.1	524	1.7	2.7
Maize area (ha)	252	2.1	3.1	681	1.8	1.7	246	2.1	2.9	524	1.8	1.8
Sorghum area (ha)	252	7.9	12.6	681	5.5	19	246	7.8	12.5	524	5.5	20.7
All cattle (number)	252	2.6	2.4	681	1.8	2	246	2.6	2.3	524	1.9	2.1
Draft cattle (number)	252	26.1	35.5	681	16.4	20.9	246	25.9	35.5	524	17.1	21.7
Poultry (number)												

Note: Treated group refers to the households living in the villages where the warehouses were built in 2013. Control group refers to the households living in the villages that were not offered to participate in the project. The main cause of attrition is due to the decision of one village in the control group to leave the program and not to participate in the final survey in 2016.

Table 3: Representativeness of the sample

Baseline survey	Sample (N=770)		National survey (N=265)	
	Mean	Std. Dev.	Mean	Std. Dev.
Total land area (ha)	8.04	6.9	7.4	xx
Cotton area (ha)	3.46	3.84	2.6	xx
Maize area (ha)	1.91	2.81	1.5	xx
Sorghum area (ha)	1.86	2.22	xx	xx
All cattle (number)	6.24	18.5	xx	xx
Draft cattle (number)	2.11	2.16	xx	xx
Poultry (number)	19.91	27.2	xx	xx

Note: This table displays summary statistics for main characteristics of farmers. The second column displays an extraction from a national agricultural survey led in 2013 by the Ministry of Agriculture of Burkina Faso. This sample is representative of the Tuy and Mouhoun regions.

Table 4: Participation in warrantage: summary statistics

Characteristics	Loan			All
	no loan	< max. ]0%,80%[	=max. 80%	
Participation in 2013	0%			All
Number of farmers	10	26	67	103
Average nb of maize bags stored	6	18.7	13.5	14.1
Average nb of sorghum bags stored	1.2	1.7	1.7	1.7
Average nb of millet bags stored	1	0.9	0.3	0.5
Average share of harvest stored (%)	31.5	41.8	22.2	28.1
Average amount of credit (kCFA)	0	89.2	124.7	103.6
Participation in 2015				
Number of farmers	38	77	38	167 <sup>(a)</sup>
Average nb of maize bags stored	3.6	13.0	12.3	10.4
Average nb of sorghum bags stored	0.6	1.4	0.6	1.0
Average nb of millet bags stored	0.2	0.4	0.0	0.2
Average share of harvest stored (%)	29	39	35	34
Average amount of credit (kCFA)	0	80.9	136.1	84.3

Note: This table shows summary statistics for the three groups of participants: Column “no loan” refers to those who stored some grain without taking up a loan; Column “< max.” refers to those who borrowed less than the maximum amount allowed for a loan and Column “= max.” refers to those who borrowed the maximum amount allowed (80% of the value of stored bags). (a) For 14 participants in 2015, data on the credit was not available and/or inconsistent, which results in missing data. Consequently, the number of participants by type of credit does not sum to 167.

Table 5: Impact on land use and animals: ITT estimates

Outcome	(1)	(2)		(3)	
	sample mean	ITT regression		ITT regression	
	$y_1$	coef.	s.e.	coef.	s.e.
Total land area (ha)	8.56	0.7	0.74	0.92	0.63
Cotton area (ha)	4.16	0.73	0.68	0.7	0.52
Maize area (ha)	2.09	0.01	0.22	0.24	0.19
Sorghum area (ha)	1.58	0.22	0.28	0.28	0.22
All cattle (number)	5.63	1.45	0.14	1.05	0.81
Draft cattle (number)	2.01	1.01	0.26	-0.14	0.2
Poultry (number)	14.36	3.58	3.58	-1.42	2.73
Sheep (number)	3.8	0.42	0.42	0.52	0.32
Fertilizer use (kg)	811	91.02	128.37	87.2	71.66
Cotton harvest (kg)	3,758	68.87	575.34	294.81	514.46
Maize harvest (kg)	2,947	-43.49	241.77	122.54	205.84
Sorghum harvest (kg)	1,039	-39.7	293.01	-67.3	241.11
Covariates included		No		Yes	

Note: This table presents the ITT estimates. Column 1 gives the mean value of the outcome level ( $y_1$ ) amongst treated households in 2016. Column 2 gives the ITT using an OLS regression that does not include any covariates as controls. Column 3 gives the ITT using an OLS regression that includes a set of covariates as controls: the total land area (in ha), the cotton area (in ha), the maize area (in ha), the sorghum area (in ha), the education level of the head of the family (literate=1), the family size (number), the number of ploughs, the labor force (number of active members), the cattle (number), the draft cattle (number), poultry (number), fertilizer use (in kg), credit access (yes=1). Robust standard errors are adjusted for village clusters.

Table 6: Impact on access to sufficient food: ITT estimates

Outcome	(1)	(2)		(3)	
	sample mean	ITT regression		ITT regression	
	$y_1$	coef.	s.e.	coef.	s.e.
Cereals still in stock (yes=1)	0.84	-0.05	0.05	-0.01	0.04
Cereals in sufficient quantities (yes=1)	0.69	-0.07	0.08	0	0.06
Self-sufficiency (days)	79	-0.17	9.87	8.02	7.3
Quantity of maize in stock (kg)	477	-184.72	192.76	25.67	139.12
Quantity of sorghum in stock (kg)	244	-133.07	253.19	-47.05	132.11
Quantity of millet in stock (kg)	85	40.57	37.15	52.14	26.4
Covariates included		No		Yes	

Note: This table presents the ITT estimates. Column 1 gives the mean value of the outcome level ( $y_1$ ) amongst treated households in 2016. Column 2 gives the ITT using an OLS regression that does not include any covariates as controls. Column 3 gives the ITT using an OLS regression that includes a set of covariates as controls: the total land area (in ha), the cotton area (in ha), the maize area (in ha), the sorghum area (in ha), the education level of the head of the family (literate=1), the family size (number), the number of ploughs, the labor force (number of active members), the cattle (number), the draft cattle (number), poultry (number), fertilizer use (in kg), credit access (yes=1). Robust standard errors are adjusted for village clusters.

Table 7: Participants vs Never-participants: Summary statistics

Baseline survey	Never-participants (N=323)		Participants in 2015 (N=180)	
	Mean	Std. Dev.	Mean	Std. Dev.
Literate (yes=1)	0.31	0.46	0.43	0.5
Family size (number)	10	7	12	9
Ploughs (number)	1.63	1.41	1.91	1.49
Labor force (number)	5.75	3.76	6.68	5.35
All cattle (number)	5.76	25.76	4.85	7.21
Draft cattle (number)	1.69	2.04	2.14	1.99
Poultry (number)	15	19	20	25
Fertilizer use (kg)	458	524	771	843
Credit (yes=1)	0.61	0.49	0.66	0.47
Total land area (ha)	6.17	4.58	8.96	6.93
Cotton area (ha)	2.5	2.83	3.76	3.82
Maize area (ha)	1.54	2.18	1.85	2.89
Sorghum area (ha)	1.49	1.49	2.21	2.12

Note: Participants are the households living in the villages where the warehouses were built in 2013, who actually used the warrantage scheme in 2015 (and possibly in the years before). Never-participants refer to the households living in the villages where the warehouses were built in 2013, who decided not to use the warrantage scheme (neither in 2015 nor before).

Table 8: Balancing tests before and after matching

Variables in 2013	(1) Treated	(2) Control (ipwra)	(3) Control (2-nn)	(4) SD before ipwra	(5) SD after ipwra	(6) SD before 2nn	(7) SD after 2nn
Total land area (ha)	10.9	10.1	9.8	-0.10	-0.01	-0.14	-0.04
Cotton area (ha)	4.3	3.8	3.7	-0.14	0.00	-0.16	0.01
Maize area (ha)	2.3	1.8	1.9	-0.14	-0.01	-0.13	-0.03
Sorghum area (ha)	2.1	2.2	2.1	0.05	-0.05	0.00	-0.07
Literate (yes=1)	0.5	0.4	0.4	-0.04	-0.02	-0.02	-0.14
Family size (number)	13.9	12.5	11.8	-0.15	0.00	-0.23	-0.07
Ploughs (number)	2.2	1.9	1.9	-0.18	-0.03	-0.19	-0.01
Labor force (number)	8.1	6.7	6.7	-0.24	-0.03	-0.25	-0.08
All cattle (number)	7.8	4.9	4.5	-0.29	-0.02	-0.32	-0.05
Draft cattle (number)	2.6	2.1	2.1	-0.21	-0.03	-0.24	-0.01
Poultry (number)	25.9	19.8	20.0	-0.20	-0.02	-0.19	0.02
Fertilizer use (kg)	914.3	770.7	754.5	-0.15	0.01	-0.16	0.00
Credit (yes=1)	0.7	0.7	0.7	-0.06	-0.01	-0.04	0.02

Note: This table provides mean values of pre-treatment covariates in both treated and control groups as constructed using the 2-nn and the ipwra estimators. It moreover provides the standardized difference (SD) in means the two groups. SD in means is considered negligible when it is below the suggested rule of thumb of 0.25 standard deviations (Rubin, 2001; Imbens and Wooldridge, 2009).

Table 9: Impact on participants' land use and animals

Dependent variable	(1)	(2)		(3)		(4)		(5)					
	sample mean	2-nearest-neighbor matching	s.e.	coef.	ipwr adjustment	s.e.	coef.	OLS regression	s.e.	coef.	IV regression	s.e.	
Total land area (ha)	10.71	1.51	**	0.68	1.00	*	0.54	1.36	**	0.64	2.41	**	1.04
Cotton area (ha)	5.57	1.45	***	0.47	1.17	***	0.35	1.29	**	0.51	1.70	***	0.62
Maize area (ha)	2.41	0.35	*	0.21	0.28	**	0.14	0.28	*	0.14	0.65	**	0.33
Sorghum area (ha)	1.78	-0.12		0.22	-0.07		0.22	0.06		0.26	0.82	*	0.44
All cattle (number)	6.33	1.43	◇	0.91	1.39	**	0.65	1.54	**	0.66	2.71	*	1.42
Draft cattle (number)	2.53	0.07		0.21	0.07		0.17	0.09		0.21	-0.39		0.32
Poultry (number)	18.43	2.28		2.78	0.05		2.22	0.70		3.04	-3.96		4.78
Sheep (number)	4.50	0.44		0.52	1.18	**	0.50	1.15	**	0.48	1.36		1.05
Fertilizer use (kg)	1125.28	192.99	**	76.33	189.14	***	58.88	202.09	**	77.67	230.04	**	117.20
Cotton harvest (kg)	5321.49	827.95	*	430.22	754.25	**	336.20	913.68	◇	548.41	781.65		664.56
Maize harvest (kg)	3732.01	474.32	◇	324.81	476.93	*	252.65	529.51		328.86	321.95		607.30
Sorghum harvest (kg)	1219.51	-153.51		178.10	-132.00		158.74	-142.85		296.42	-177.05		330.77

Note: This table presents the estimates using the DID approach. Column 1 gives the mean value of the outcome level ( $y_1$ ) amongst treated households in 2016. Column 2 gives the ATT using the 2-nearest-neighbor estimator, along with the robust standard-error estimator provided by Abadie and Imbens (2006, 2011, 2012). Column 3 gives the ATT using the inverse-probability-weighted regression adjustment (ipwra) estimator, along with robust standard errors. Column 4 gives the ATT using an ordinary least squares (ols) regression, along with robust standard errors adjusted for village clusters. Column 5 gives the ATT using an instrumental variable (IV) regression taking the (random) location of warehouses as an instrument for participation in warrantage, along with robust standard errors. The \*\*\*, \*\*, \* and ◇ indicate that the estimated coefficients are statistically significant at the 1%, 5%, 10% and 15% levels, respectively.



Table 10: Impact on participants' access to sufficient food

Dependent variable	(1)		(2)		(3)		(4)		(5)	
	sample mean	$y_1$	2-nearest-neighbor matching	coef.	s.e.	ipwr adjustment	coef.	s.e.	OLS	IV
Cereals still in stock (yes=1)	0.94	0.09	**	0.04	0.06	**	0.03	(a)	0.01	(a)
Cereals stored in sufficient quantities (yes=1)	0.81	0.13	***	0.05	0.07	*	0.04	(a)	0.03	(a)
Self-sufficiency (days)	95.4	17.4	***	6.6	17.7	***	5.6	17.1 *	8.5	21.3 *
Quantity of maize in stock (kg)	746.0	213.2	**	101.5	197.6	*	104.1	216.5	178.0	58.1
Quantity of sorghum in stock (kg)	318.8	-167.7		209.8	-98.6		125.2	-71.6	205.3	-68.9
Quantity of millet in stock (kg)	94.81	34.2		51.9	42.1		49.1	33.6	47.6	130.8

Note: Column 1 gives the mean value of the outcome level ( $y_1$ ) amongst treated households in 2016. Column 2 gives the ATT using the 2-nearest-neighbor estimator, along with the robust standard-error estimator provided by Abadie and Imbens (2006, 2011, 2012). Column 3 gives the ATT using the inverse-probability-weighted regression adjustment (ipwra) estimator, along with robust standard errors. Column 4 gives the ATT using an ordinary least squares (ols) regression, along with robust standard errors adjusted for village clusters. Column 5 gives the ATT using an instrumental variable (IV) regression taking the (random) location of warehouses as an instrument for participation in warrantage, along with robust standard errors. (a) For binary dependent variables, Columns (4) and (5) provide the marginal effect calculated from a probit model (in those cases, standard errors are not provided). The \*\*\*, \*\*, \* and  $\diamond$  indicate that the estimated coefficients are statistically significant at the 1%, 5%, 10% and 15% levels, respectively.

Table 11: Impact on participants' food families consumed

Food family consumed	(1)	(2)		(3)		(4)	(5)
	mean	$y_1$	coef.	s.e.	coef.	s.e.	coef.
Several times a week (yes=1)							
leguminous	0.05	-0.04	0.03	-0.03	0.02	-0.03	-0.01
oleaginous	0.20	0.01	0.05	0.04	0.04	0.03	-0.04
meat	0.20	0.03	0.04	-0.01	0.04	-0.01	-0.11
fish	0.66	0.13	**	0.06	0.15	***	0.05
dairy products	0.07	-0.01	0.03	0.00	0.02	0.00	0.20
eggs	0.05	0.03	0.02	0.03	0.02	0.02	0.03
oil	0.88	0.09	**	0.04	0.10	***	0.09
vegetables	0.25	-0.05		-0.04	0.04	-0.02	0.12
fruits	0.05	0.03	*	0.00	0.04	0.04	-0.11
sugars	0.85	-0.01	0.02	-0.04	0.03	-0.04	0.16
sauce and condiment	0.99	0.03	0.02	0.02	0.14	0.02	0.02
Daily (yes=1)							
leguminous	0.01	0.00	0.01	0.00	0.01	0.00	0.03
oleaginous	0.06	-0.04	0.04	-0.01	0.02	-0.01	-0.04
meat	0.03	0.02	0.02	0.00	0.02	0.00	-0.02
fish	0.38	0.08	◇	0.10	**	0.05	0.08
dairy products	0.04	0.00	0.03	0.00	0.02	0.00	0.04
eggs	0.01	0.01	0.01	0.01	0.01	0.00	0.01
oil	0.68	0.07	0.06	0.08	*	0.05	0.06
vegetables	0.18	-0.03	0.05	0.01	0.04	0.02	0.08
fruits	0.03	0.02	◇	0.03	**	0.01	-0.05
sugars	0.73	-0.03	0.05	-0.05	0.04	-0.04	0.03
sauce and condiment	0.98	0.09	***	0.03	0.09	0.08	-0.13
							◇
							***

Note: A food family is said to be consumed "several times a week" (resp. "daily") if the respondent stated that he consumed this food family 3 or 4 times (resp. 5 times or more) the week before he was surveyed. Column 1 gives the mean value of the outcome level ( $y_1$ ) amongst treated households in 2016. Column 2 gives the ATT using the 2-nearest-neighbor estimator (2-*nn*). Column 3 gives the ATT using the *ipwra* estimator. Column 4 gives the ATT using an *ols* regression. Column 5 gives the ATT using an *IV* regression. (a) For binary dependent variables, Columns (4) and (5) provide the marginal effect calculated from a probit model (in those cases, standard errors are not provided). The \*\*\*, \*\*, \* and ◇ indicate that the estimated coefficients are statistically significant at the 1%, 5%, 10% and 15% levels, respectively.

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