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Helping Poor Farmers to Help Themselves

Evidence from a Group-Based Aid Project in Mozambique

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Abstract

This paper evaluates the impact of an integrated rural development programme on farming techniques and food security in the Gaza area of rural Mozambique. We examine the impact of a group-based approach, in a country with few impact evaluations of technology adoption in farming. Using self-collected panel data on over 200 households from treatment and control villages from 2008-10, we examine the impact of the aid programme on people living in the treatment villages, using the difference-in-differences approach, and on those who participate in the farmers' groups, using instrumental variables techniques. The results on farming activities and food security indicate some positive immediate impacts on technology adoption and self-reported food security.

Keywords: food security, farming techniques, fertilizer use, technology adoption, impact evaluation, Mozambique
JEL classification: O1, O2

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Tables are at the end of the paper.

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1 Introduction

The crucial role of agriculture in the sustainable development of sub-Saharan Africa (SSA) has now been widely recognized (WDR 2008). The case of Mozambique is illustrative in this regard. Despite years of high GDP growth rates, the latest living standard measurement survey revealed that headcount poverty had not declined at all (LSMS 2010). Arndt et al. (2011) examine the reasons for this disappointing development and they argue that one of the key reasons is that productivity in agriculture has not improved sufficiently.[1] Since the agricultural sector supports 80 per cent of Mozambique's population, agricultural growth is vital in improving the welfare of the vast majority of the poor in the future.

The adoption of new farming techniques elsewhere in Africa is also slow, but it is not completely understood why (e.g. Rogers 1995). Zavale et al. (2005) propose that productivity can be increased through improved crops and better management, so that new technologies are combined with enhancements in agricultural institutions and human capital. Furthermore, the output growth is influenced by the efficiency with which the improved technologies are utilized. Evidence of the significance of these factors in other regions was also presented in Evenson and Westphal (1994) and Foster and Rosenzweig (1995). Furthermore Uaiene et al. (2009) concluded that in Mozambique education has a positive marginal effect on the probability of adoption of new technologies. Previous literature on human capital, also in other fields than economics, suggests various factors that impact on learning and the adoption of new technologies.

Recent work has emphasised the role of social networks on farming development. In the sub-Saharan African context, Bandiera and Rasul (2006) and Conley and Udry (2010) have found evidence that social networks have an effect in the technology adoption process. Centola (2010) points out that technology adoption requires reinforcement from multiple sources. Moreover Todo et al. (2011) note that findings on technology adoption suggest that while social networks are likely to enhance the adoption of new technologies, the possible effect and magnitude vary depending on the characteristics of the network.

In this study we explore the impacts of a set of activities that aim to make farming practices more effective in the Gaza area of rural Mozambique. The activities focus on facilitating the adoption of improved technologies available to the government of Mozambique, but which are not reaching the farmers. In other words, despite the fact that the information exists, it is not fully disseminated to potential users in practice. In Mozambique weak infrastructure, especially in rural areas, low educational levels and poor access to credit have been found to influence the cost efficiency of maize cultivation and the slow adoption of new varieties (Zavale et al. 2005). Poor, uneducated women are quite often in a particularly vulnerable situation and may lack sufficient resources and capacity to benefit from new techniques. Our research focuses on an intervention to improve subsistence farming yields, which is mainly the responsibility of the women in the household. Furthermore, we attempt to identify both the community and household level impacts on the development of food security and use of new technologies.

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1 Current agricultural productivity levels are low in the country, even by regional standards (FAO 2004; Arndt et al. 2011), and the adoption of new technologies is slow, despite of a large number of promising technologies available (Uaiene et al. 2009).

The contribution of this paper is twofold. First, the intervention we examine differs from previous work in SSA. The agriculture intervention is part of a comprehensive village development programme carried out by the Lutheran World Federation (LWF) in the Gaza region in southern Mozambique. Earlier research—Conley and Udry (2010) in the Ghanaian context, and Bandiera and Rasul (2006) in Mozambique—has studied the diffusion of information and social effects of technology adoption for a cash crop that is primarily intended for the market or input use and often cultivated by men, whereas here the agriculture intervention focuses on creating groups of farmers, training these groups, setting up shared farms as a medium for technology transfer, which may lead to better commitment and benefits of social learning.

Our second contribution is to offer a fully-fledged impact evaluation of an aid project in farming in Mozambique, where this kind of evidence is scant. To the best of our knowledge, these are the first results of subsistence crop and fertilizer adoption, in a group-farming intervention, in a joint field, using panel data in Mozambique. The heavily aid-dependent country has several similar development projects in progress by multiple NGOs in different regions that are not evaluated econometrically.[2]

Our analysis is based on panel data, collected by the authors, from more than 200 households from two villages where the LWF has operated (treatment villages) and four control villages, before and after the intervention. The households were randomly sampled for the baseline study, and after the baseline year we have then followed the same households for two years. We first measure the mean impact for households who live in the treatment villages and who are therefore eligible for participation in the aid programme using the difference-in-differences (DD) approach. The outcome variables concentrate on adoption of new farming practices, including the use of improved seeds and fertilisation, as well as food security that could partially be a result of successful adoption of these practices. The DD analysis captures both the impacts of group participants and the potential impacts on outsiders via village-level externalities. However, if externalities are small, then the DD analysis underestimates the impacts on group participants. Therefore, we also estimate IV models, where living in the treatment village is used as an instrument for group participation. We also make an attempt to explicitly estimate the spill-over effects and heterogeneous treatment effects.

The results indicate that the intervention had a strong immediate impact on part of the farming activities and an impact on food security for the first year of intervention. However, the impacts on farming techniques appear to dissipate in the second aid year. There appear to be two main reasons for this: on the one hand there were delays in delivering the aid due to administrative changes on the implementation partner's side, and on the other hand there was a severe drought that particularly hit the treatment village in our study. This shock decreased farming activities in general and the farmers' willingness to experiment with new techniques. The results therefore imply that sustainable success in the adoption of new techniques in these difficult conditions requires constant presence of the aid organisation at the field, especially during the first years of the implementation when farmers are still dependent on training and continuous support.

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[2] The particular intervention we examine is supported by Finnish donors. As a part of a broader research project examining the impact of Finland's bilateral development aid, this paper presents the first econometric impact evaluation carried out of a Finnish-funded development project.

The remainder of the paper is organized as follows. Section 2 overviews the context, the aid intervention and the village development programme. Section 3 describes the data, while Section 4 introduces our econometric approach. Section 5 presents the treatment effects on immediate outcomes such as farming techniques and crops harvested on the year following the intervention[3] and Section 6 studies the impacts on food security and coping strategies that households adopt to feed the household. Section 7 takes a closer look at selection into the programme, spill-over effects and heterogeneous effects of the intervention. Section 8 concludes.

2 The context

2.1 The intervention area

The two project villages are located in the district of Chigubo in the Gaza province of Mozambique. The district consists of two administrative posts, namely Zinhane and Dindiza. The villages are located in the maize dominant semi-arid interior livelihood zone of Mozambique. Water scarcity is one of the most serious challenges in the zone. The region is vulnerable to cyclical droughts and as crop production is entirely rain-fed, drought is the most common shock affecting access to food and income. Apart from droughts, livestock/crop disease outbreaks are historically the most destabilizing factors for local production (FEWSNET, 2011). Unexpectedly heavy floods may also wash away cultivations and seed storages. Despite the unfavourable climate, subsistence farming is the main source of livelihood in the area. Crop production is combined with some livestock rearing (see table 4). Extra cash is earned through seasonal employment in agriculture, migratory work and self-employment (handicrafts, construction of huts and furniture, brewing and distilling and coal production). The villages are remote, sparsely populated and poorly integrated with market at all levels (i.e. primary, secondary and tertiary) (FEWSNET, 2011). Most households in the zone therefore sell their crop produce and livestock only locally, resulting in a rather stagnant price environment. The lean season when people struggle to have enough to eat, stretches from October to February.

In Gaza, the local government aims to operationalize the government's framework, created in cooperation with donors to build an enabling environment for agricultural development (PAEI,[4] PARPA, MADER's Visão, and ProAgri) by providing seeds for new crops and fertilizers free for farmers who proactively take the initiative. Despite the government policies, the adoption rate without interventions remains marginal (Uaiene et al. 2009; Zavale et al. 2005). Hence, without the presence of supportive organisations it is possible, but often rare, to start forming farming groups and applying for government support.

2.2 The LWF village development programme in Chigubo district

The agriculture intervention is part of a village development programme that LWF started up in June 2008 in compliance with the policies of the local government. The objectives of the village development programme are to improve villagers' livelihoods and welfare. These

[3] With immediate outcomes we always refer to outcomes in the next period.

[4] This government support (seeds and tools for poor farmers) aims to increase agricultural productivity and is part of the Mozambique Agrarian Policy and Strategy of Implementation (PAEI).

objectives are largely pursued by strengthening local community support structures and enhancing community capacity. The entire villages are therefore subject to interventions and the project objectives are pursued through both community and household-level interventions. The programme started by organizing the village into committees, training the committee members and facilitating the work of actual working groups on areas such as agriculture, health, education, microcredit, water, prevention of catastrophes. The agriculture group is the largest and most active of all of these. We are interested in seeing how the farming intervention is transmitted to actual adoption of technologies and how it strengthens households' capacity to become food secure.

The project interventions on food security focus on creating groups of farmers, training these groups, and setting up demonstration farms/joint plots as a means of technology transfer. An introductory meeting and farmers' group activities were organized so that everyone in the village could be informed and have the possibility to join. All interested villagers have the possibility to participate in actual hands-on working groups.

The intervention started in October 2008 in two villages near the administrative post of Dindiza. In 2009 it continued in the same villages. Later, in mid-2010, the village development program expanded to a third village. However the farming activities using new techniques started only after the third round of interviews. Thus in practice, there are only two actual treatment villages in this study. The two effective villages that were chosen to join the programme in Chigubo were selected according to relevance and their own consent/interest. Water insecurity and economic vulnerability were important criteria; in fact the descriptive analysis below reveals that project villages were disadvantaged in several ways. In each of the two treatment villages there are two farmers' groups. Participation in groups is voluntary and one member is free to join several groups. As the new technologies are related to the subsistence farming crops, the majority of the farmers who decided to join are women. The farmers may consume and sell[5] their harvest and products freely. The Gaza intervention supports social learning as it takes place in a group on a shared field that has fences[6] to mark the cultivated plots of land. The farmers meet the aid workers twice a month to discuss farming practices, problems and concerns with the aid workers. Otherwise they solve problems independently or together with other group members on the field.

The government and LWF provide training, seeds, fertilizers, pesticides and some small equipment. In contrast to previous research, this study does not focus on analysing the adoption of one improved plant, but rather the possibility of choosing a mix of up to eight different plants and other farming technology such as pesticides and fertilizers.[7] The first two of these new plants are root vegetables, sweet potato and cassava, which are important sources of essential nutrients in SSA. Cassava is a promising plant for the farmers in Chigubo as it gives one of the highest yields of food energy per cultivated area and does well on poor soils and with low precipitation. Because it is a perennial plant, it can be harvested as necessary, which allows it to act as a famine reserve or as a cash crop. Sweet potato is also a suitable plant for limited farming conditions as it grows in poor soils with little fertilizer. The

[5] No particular entrepreneurship training was given to the farmers.

[6] Normally the land is owned by the state of Mozambique and farmers have rights to use it. This may have adverse effects on the land productivity in the sense that farmers cannot let it fallow for natural revitalization in fear of losing it. In the intervention the farmers were given rights from the government to build fences for their group plot, so the risk of losing the land in the future is smaller.

[7] However, risk-sharing and joint learning works if everybody is cultivating the same crops and using the same technologies.

six other horticultural plants are cabbage, tomatoes, lettuce, onion, butter beans and Matuba maize. Matuba maize is an improved open pollinated white variety of maize that has been selected by Mozambique's national agricultural research system INIA[8] and is well adapted to poor management conditions, drought and low input farming. Matuba's earliness (up to 110 days maturity) represents a drought mitigation strategy (Ransom et al.1996). Moreover, maize is the most cultivated plant in the area, so this improvement may be adopted more easily. Matuba maize can be used as a food and cash crop. The farmers were also provided with fertilizers (ammonium sulphate and urea) regularly for the entire evaluation period and pesticides (Mancozeb and Cipermetrim) for the first year to improve the yield of the new plants. Each farmers group was provided with a motor pump, a garden rake, a hoe, an axe and an irrigation blade[9].

Throughout SSA, farmers traditionally keep some of the harvest as seeds for the next season's crop, except if they experience catastrophes when they have to consume their seed stock for food. If seeds can be provided on a regular basis then farmers' uncertainty related to the future could decrease and their ability to recover from catastrophes can increase. However, this also makes the farmers more dependent on the implementing partner before the farmers become self-sufficient.

3 Data

3.1 Data collection

We administered a household survey in 2008, 2009 and 2010. The baseline data of 2008 was collected in September prior to the start of the activities of the agriculture interventions in October (Figure 1). Two survey rounds were carried out after the baseline; in October 2009 and September 2010. The one month difference in the data collection point may have affected the comparability of the two years. The year 2010 experienced a severe drought that affected farming. In addition, due to elections at the start of 2010, there were some inconsistencies in seed distribution and other activities which most probably have affected the harvest in September 2010. The data was collected on two project villages (Swiswi and Nongoti) and four control villages (Saute, Nhanal, Queque, Solane). Control villages were chosen based on comparability and similarity of the development patterns. Geographically, the control villages are also relatively close to the treatment villages.

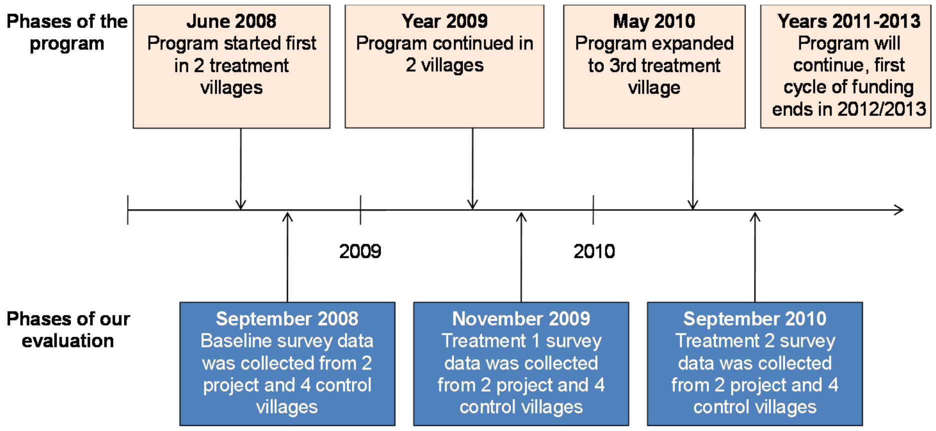
Data collection was carried out with the help of qualified and trained local interviewers, LWF staff and the National Institute of Health of Mozambique (NIH). The interviewers were trained by experienced researchers from the NIH and supervised in the field by our research team members. Interviews were carried out with 232 randomly selected households in the six villages. Poor availability of information prior to the survey made stratification impossible; a simple randomized sampling of households was therefore performed. Table 1 reports the number of households interviewed in each survey year and the total number of households in each village. The non-response rate in the first round and the attrition rates in the subsequent rounds were very low—partly because of our intentional effort to track all households in all years—and should not lead to any bias in the result (Table 1). The head of the household was interviewed if he/she was present, otherwise the nearest adult with information about

[8] Instituto Nacional de Investigacao Agronomica.

[9] This equipment was provided by the government and brought to farmers by the implementing partner.

household matters.[10] The same person was usually interviewed from year to year, depending on feasibility.

Figure 1: Timeline of the development programme and our evaluation



Source: authors' Illustration.

The household survey questionnaire was based on the traditional Living Standard Measurement Surveys of the World Bank and the Mozambique Household Budget Survey. Additional questions relevant for the present study were also included. To design relevant questionnaires, semi-structured interviews were carried out in village meetings in the two project villages, Nongoti and Swiswi prior to the data collection. The household questionnaire collected a wide range of detailed information on various aspects of household economy, including wealth, assets and food security, remittances, networks, shocks and coping strategies, activities, household characteristics, education, land use, health, demographic characteristics, location data and aid from other organizations.

The villages are small with typically less than 300 households in each. They are remote—the journey time by car to the nearest town takes up to three hours or more. Households are also dispersed to a large area as the self-reported distance in hours to the nearest health centre is on average more than three hours by foot.

In terms of uptake, the answers provided by the households in the 2009 survey and the figures from the implementing partner match surprisingly well. LWF reports that the aggregate adoption rate was 90 per cent in Swiswi and over 45 per cent in Nongoti and the implementing partner did not report any dropouts from the programme. However, in the data the adoption rate decreased during intervention from 90 per cent to 66 per cent in Swiswi and from 43 per cent to 32 per cent in Nongoti, where a significant amount of households that had reported to participate in 2009 did not report to participate in 2010 (66 per cent decline), but new households had joined the groups that did not report being there in 2009 (35 per cent). Thus in 2010 new untrained households had replaced households that had dropped out of the programme. These self-reports can, however be subject to missing information bias.

According to the baseline data, less than one fifth of the households participated in groups or networks (e.g. religious networks). After the intervention more than half reported that they

10 Household decision-making over participation and technology adoption is assumed to follow a collective model. However, the yields could benefit the subsistence farmer and her children more.

actively participate in farmer groups and some reported that they were active in women's groups or village committees in the treated communities. There were a handful of households who had a farmers' group in one of the control villages.

3.2 Descriptive statistics: households' demographics, water security, and livelihoods

Below we report some descriptive statistics of the data that we analyse further in section 5 to 7. Demographic characteristics of the households, their water security and their means of livelihood are likely to affect how households' respond to the intervention and will therefore be central in our analysis. We will concentrate on these aspects below. This section will also give us a sense of the extent to which the control villages represent a good counterfactual to the programme villages. Most of the variables presented below will be used as controls in Sections 5 to 7.

Table 2 reports some basic household and member characteristics for the baseline year 2008. Differences in demographic characteristics are mostly marginal between project and control villages and the differences in the means and proportions are not statistically significant. The baseline survey was undertaken at the end of the most active season for migrant work which stretches from June to September when there is a break in the agricultural activities. In 43 per cent of the households either the head or another household member is away for migration. In 13 per cent of the households, the head is away. While not reported in Table 2, approximately 75 per cent of the migrants are male. As a consequence, there are more women than men present in the villages and 37 per cent of the household heads are women[11]. Hence, migration, the sex distribution within the villages and the prevalence of female-headed households are related.

As noted above, crop production is entirely rain-fed and as a consequence droughts are one of the most destabilizing factors for local production. Table 3 shows the cumulative amount of rain in the villages for the rainy seasons of the years 2008-10. It can be noted that the amount of rain decreases over the period and that the trend is weaker in the treatment villages compared to the control villages. Since wells and other water sources are shallow and may dry out, not only the amount of rain but also the access to drinking water varies. Compared to control villages, access to water varies more in project villages over the years. In 2008 no households in project villages report that they have to rely on rivers, springs and ponds for their drinking water. In 2009 this rose to 25 per cent and in 2010 it dropped back to 15 per cent.[12] The use of springs and ponds may be an indicator for good water security, if far away wells are used mostly during dry periods.

Climatic conditions are also reflected by the land households cultivate. High land is prone to droughts whereas low lands are prone to floods. Households that have access to both high and low land diversify according to rain fall. As is evident from Table 3, the use of low land increases over 2008-10 as the rain fall decreases in most villages over the same period[13]. In 2008, 85 per cent of the households in project villages and 84 per cent in control villages use

[11] If the original head is migrated, another member, usually the spouse, has been assigned to be head of household.

[12] In 2010, households in Swiswi get access to a well with a pump.

[13] The use of low and high land is self-reported by the households. There is a clear distinction between high and low land.

high land. In 2010 this has fallen to 52 and 63 per cent respectively. A higher proportion of farmers have started to use both low and high land in project villages.

Crop production complemented with livestock rearing forms the basis of livelihoods in this area. Since crop production is entirely rain fed and the sandy soil is of low fertility and generally has poor moist retention capacity, ownership of livestock is important and a key determinant of wealth. Better-off and middle-income households typically raise cattle whereas poor households only have goats and chicken (FEWSNET 2011). Our data suggest that while there are households that live on agriculture alone, there are only a very small number of pure pastoralists.

Table 4 shows details about farming and livestock. The top panel shows the number of hectares used by the households in 2008.[14] The median size is 3 hectares for both project and control villages and the mean size between 3.5 and 4. The means are close to the threshold between poor and middle income households in the area (4 hectares) as reported by FEWSNET (2011). The most common crops in both project and control villages are maize, cow peas and peanuts. In addition, pumpkin and water melon are fairly common.

Three per cent of the households in project villages and six per cent in control villages report that they did not cultivate any crops). Households in control villages generally cultivate a smaller number of crops. This is explained by the fact that livestock rearing is more common in control villages. The lowest panel in Table 4 gives details of type of animal groups that households own and a tropical livestock units (TLU), that summarizes the number of animals owned per household by the type and size of the animal[15]. Of the households, 15 per cent in the project villages and 14 per cent in the control villages report that they have no livestock. Poultry is owned by a little more than 70 per cent of the households. Sheep and goats are more commonly held in control villages (64 per cent) than project villages (41 per cent). However, the average TLU is not statistically significant between project and control villages.

In terms of comparability of project and programme villages, the conclusion to be drawn from the descriptive statistics is that they are on average very similar when it comes to demographic characteristics. In terms of livelihood strategies, the differences are not large, but project villages are slightly more agricultural while control villages are more agro-pastoral. Given the importance of livestock as a determinant of wealth, it also suggests that control villages are a bit better-off. Project villages are also slightly more water insecure than control villages. All these aspects are important to control for in the analysis below.

3.3 Food security and coping strategies

Food security is a central part of our analysis but is not straightforward to measure. Below we will describe the indicators used to analyse food security, their descriptive statistics and the correlation of different indicators used.

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[14] Land is usually owned by the state in Mozambique. Households have a right to use land on certain restrictions.

[15] Tropical livestock units (TLU) provide a convenient method for quantifying a wide range of different livestock types and sizes in a standardised manner. One TLU is approximately 250 kg of live weight. We use the following weights: 0.7 for bulls and cows, 0.4 for donkeys, 0.15 for sheep, 0.1 for goats and dogs and 0.02 for poultry. In other words a cow is worth 35 times a chicken.

Food sufficiency was asked about in a number of questions. In all survey rounds households were inquired about their ability to have regular meals, how many meals they consumed on average per day and sufficient availability of the main staples (maize, cow peas and sorghum) during the six months preceding the survey.

In 2009, questions to construct two composite indicators were added. One of the indicators is the food consumption score (FCS), a proxy indicator for food security based on the number of food groups consumed over a seven day recall period (see Appendix 1 for details). Each food group is given a frequency score depending on the number of days it was a consumed, and a weight reflecting its nutrient density. The score obtained is compared with pre-established thresholds, indicating whether the food consumption is poor, borderline or acceptable.

The coping strategy index (CSI) is another proxy indicator for food security which is based on questions around the food-based coping strategies that people use, with the past month as the recall period. The questions range from relying on less preferred and less expensive food to sending household members to beg. Each question is given a frequency score depending on the number of times this strategy was used and a weight reflecting its severity (see Appendix 1 for details). In the case of the CSI, a high score reflects more negative coping strategies. The questions for the CSI and the corresponding weights are based on WFP (2009) and adapted to local conditions.[16] Unlike the FCS, thresholds are not established for this index.

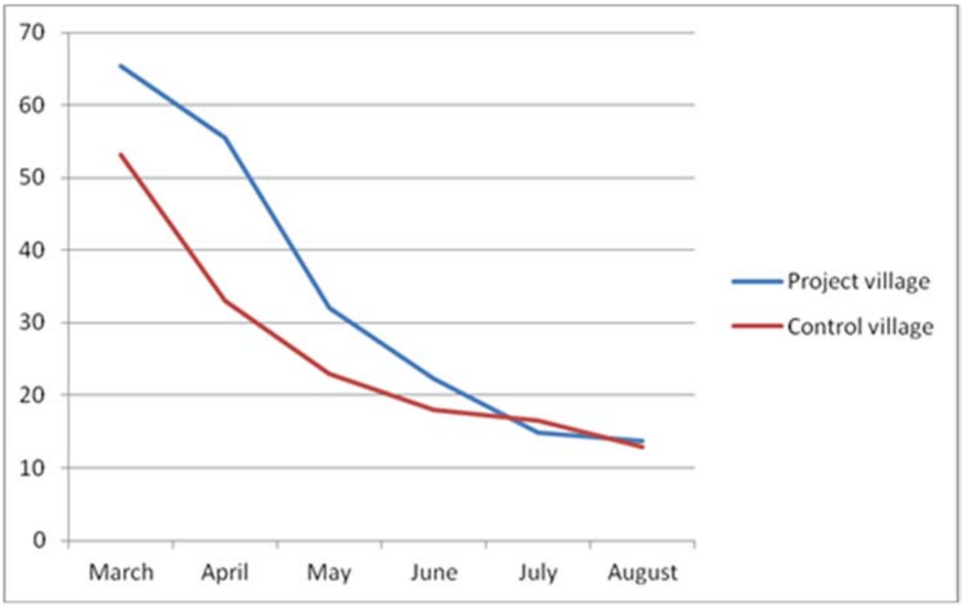
Figure 2 shows the availability of the main staples for the six months preceding the survey in 2008.[17] The main staples are harvested early in the year so sufficient availability falls as expected from March to August. The point to be illustrated here is that households at the time of the interview hold relatively small amounts of the main staples which will affect their food security and coping strategies. The intra-year food insecurity is not at its peak, however, as the lean season starts in October.

Table 5 reports descriptive statistics of FCS, CSI and ability to have regular meals in 2009. The average FCS is just below 30 in both project and control villages. This represents a level of borderline food consumption. One year into the intervention, project villages have lower CSI than control villages, indicating that project villages use less severe coping strategies to maintain their food security, which indicates a positive effect of the project on food security.

16 To gather wild food, hunt or harvest immature crops is normally given the highest severity weight. In Chigubo gathering wild food and hunting is a very common coping strategy and was therefore given a lower weight.

17 Due to a change in the translation of the question, the data for 2010 is not comparable to the previous years and therefore not reported here.

Figure 2: Months enough of maize, sorghum and cow peas, 2008



Source: authors' illustration.

The households in both project and control villages are spread fairly evenly over the categories indicating poor, borderline and acceptable food consumption. As expected, FCS and CSI are negatively correlated: the lower the FCS, the more negative coping strategies the households have to resort to. What is not very correlated at all is the ability to have regular meals and FCS. This probably reveals weaknesses in both of the indicators and shows that food security has to be measured in several different ways. Finally we show that there is a positive correlation between FCS and TLU. In the analysis below we use TLUs owned by the household as a proxy for household wealth.

Table 6 takes a closer look at the components of CSI. Households are asked how often they have had to resort to a number of coping strategies as a result of not having enough food during the past month. Here we only report the share of households that use a specific strategy, not how often this strategy is being used. Strategies such as relying on less preferred or less expensive food or limiting portion sizes are very common and used by 75 to 80 per cent of the households. Typically for this area, gathering wild plants, hunting and harvesting immature crops are also common.

4 Empirical strategy

We start out by estimating three types of models to capture the intention to treat effect and the average treatment effect of the treated. In section 7 we then extend our analysis to include spill-over effects. Our first approach is a difference-in-differences (DD) analysis whereby we compare changes for households living in treatment villages to those living in control villages. We first estimate a pooled regression of the form:

$$y_{i,v,t} = \alpha^1 + X_{i,t}\beta^1 + \sum \lambda_t^1 year_t + \sum \phi_v^1 village_v + \delta^1 (treat\_vil * treat\_year)_{i,v,t} + \varepsilon_{i,v,t}^1$$

and household-level fixed effects equations of the following form:

$$y_{i,v,t} = \alpha_i^2 + X_{i,t}\beta^2 + \sum \lambda_t^2 year_t + \delta^2 (treat\_vil * treat\_year)_{i,v,t} + \varepsilon_{i,v,t}^2 ,$$

where $y_{i,v,t}$ denotes the outcome variable of household *i* in village *v* at time *t* and $year_t$ is the year dummy. $X_{i,t}$ refers to a vector of household level controls in the case of the pooled regression and to a set of time-variant household-level controls in the household fixed effects regression. The exact control variables can change somewhat depending on the dependent variable. In the pooled regression, $village_v$ is the village dummy. Note that village-level dummies are not included in the fixed effects regression since we have household fixed effects and households typically do not move. The parameters δ^1 and δ^2 are our main interest as they measure the effect of living in a treatment village in a treatment year.

The identifying assumption is a standard difference-in-difference assumption that the households' situation would evolve similarly across the villages in the absence of the aid project. We can allow for permanent, time-invariant, differences between the households (and the villages) and year effects that are common for all villages. We are not aware of any threats to the identification; i.e. it is unlikely that there would have been other simultaneous forces that would have favoured those living in the treatment villages. In fact the need factors that affected choosing the treatment villages in the first place may have disfavoured those living in the treatment villages. Hence it may have made the counterfactual growth pace slower in the treatment villages, which may bias our results, but this bias can partly be taken care of by including the covariates.

One of the benefits of the difference-in-differences analysis is that it measures the impact of the intervention, not only on those participating in the groups helped by the LWF, but also on those who stay outside of the groups and potentially benefit from the aid work via spill-over effects. Using the jargon of impact evaluation econometrics, the DD analysis represents 'intention to treat' effects; i.e. the mean effect of aid among those eligible for it. However, since not all of the households participate in the aid groups, but the treatment is also measured among the non-participating households, the DD analysis underestimates the impact of the aid project on group participants. Therefore, it can be seen as a lower bound for the effects of the aid programme.

To capture the impact of aid on group participants, we cannot directly compare group members and outsiders, since group membership can easily be endogenous to the same unobservable variables that determine success in farming. We therefore use living in the treatment village as an instrument for group participation. The use of the intention to treat variable as an instrument hinges on the assumption that programme placement is as good as randomized from a group formation perspective[18]. Our third approach is to estimate equations of the form:

[18] A conservative approach would be only to use the 'intention to treat variable' only if programme placement was randomized.

$$y_{i,v,t} = \alpha_i^3 + X_{i,t}\beta^3 + \sum \lambda_t^3 year_t + \delta^3 \hat{m}_{i,v,t} + \varepsilon_{i,v,t}^3 \ ,$$

where $\hat{m}_{i,v,t}$ refers to those who are members of a farmer's group. This equation is estimated using 2SLS where the first stage is:

$$m_{i,v,t} = \alpha_i^4 + X_{i,t}\beta^4 + \sum \lambda_t^4 year_t + \delta^4 (treat\_vil * treat\_year)_{i,v,t} + \varepsilon_{i,v,t}^4 \ .$$

This is estimated using linear probabilities. In this IV framework, we use the same set of control variables than in the case of the DD analysis.

In the absence of treatment heterogeneity, the estimate for δ^4 is the average treatment effect on the treated (ATET). Due to imperfect take-up, however, there is a selection effect that most likely is not fully captured. Since the instrument indicates different policy regimes (aid intervention versus not) rather than explaining why a particular household chose to participate in the programme when it was available, it is possible that the households participating are different from those not participating due to characteristics that we do not fully capture with observable variables. What we identify here is therefore the effect of the intervention on those households that start to participate in farming groups due to a change in the instrument, in this case due to the introduction of the aid intervention. Assuming that the spill-over effects are small (see section 7 below), we capture a local average treatment effect (LATE).[19] While LATEs are not always especially informative, we would argue that in this case our LATE is, since the instrument is itself the policy in question and it is relevant to know how programme participants' positions are affected.

Notice, however, that while there are also groups set by the farmers themselves in the control villages, there are quite a few of them, and therefore the IV estimates are approximately equal to the DD estimates divided by the share of the group members from village population. In other words, the DD estimates are multiplied by the inverse of the 'take-up' rate of aid. To see this, since both the eligibility for the aid project and group membership are dummy variables, the IV estimate for the effect of the aid project is the Wald estimate:

$$\delta_{WALD} = \frac{E[Y_i \mid R_i = 1] - E[Y_i \mid R_i = 0]}{E[m_i \mid R_i = 1] - E[m_i \mid R_i = 0]}$$

where Y is the outcome of interest, R denotes the aid villages and m indicates that the household is a group member. The numerator in this expression is the difference in the outcome variable between the households that are eligible for aid (intention to treat), and the denominator is the difference in the fraction which actually receives aid (the 'take-up' rate); i.e. belongs to a group. If receiving aid is uncommon among those who are not eligible for the subsidy, then $E[m_i \mid R_i = 0]$ is close to zero, and the Wald estimate simply scales up the effects by multiplying the difference between eligible and ineligible persons by the inverse of the take-up rate.

[19] LATE is due to Imbens and Angrist (1994). See also Heckman (1997) and Angrist et al. (1996).

The outcome variables that we use relate to farming techniques and food security. These include:

- an indicator variable if the household uses fertilizers on its fields
- a variable if the household uses improved varieties of existing crops
- the number of crops farmed (this is used to measure if the farmers start to use new crops)
- an indicator variable on the ability to have regular meals
- coping strategy index
- food consumption score.

The control variables relate to the key aspects noted in section 4: access to water, demographics and means of livelihood. To capture the first aspect, we add a variable on the cumulative rainfall during the rainy season over the three years. As noted above, the trend in the treatment villages was weak during the period. This may have had an effect on the interest of farmers to experiment with new techniques. Related to climatic circumstances we also take into account what type of land the household uses each year: high land (reference category), low land or a combination of both. This can be controlled for, since the project did not seek to affect this choice. We will not use source of drinking water, however, as the project might have had an impact on this.

We include demographic information as reported in Section 4 on household size, number of children, whether household head is female, if head or spouse is literate and marital status of head (monogamy used as reference category). We also control for whether there is an ill person in the household, or not, and whether the head of the household has migrated or not. We expect that the head being away might have an impact on household decision-making.

To indicate livelihood type, we add a dummy for whether the household owns livestock or not.[20] To get a sense of the wealth level of the household we add information on number TLUs owned and number of hectares in use. As detailed above, these are important variables for wealth status in the area. Heteroscedasticity robust standard errors are used throughout; in the pooled regression we also account for the fact that the same household appear several times in the data.[21]

5 Results on farming techniques and crops harvested

We first consider the impact of the intervention on farming techniques. These constitute immediate outcomes of the project. We study the use of fertilizers, the number of crops harvested and the number of new crop varieties used.

Figure 3 below illustrates what has happened in the use of fertilizers during this period. It demonstrates that there was a large increase in the share of farmers using fertilizers at their plots immediately after the start of the intervention, but the effect diminishes to a large extent the following year.

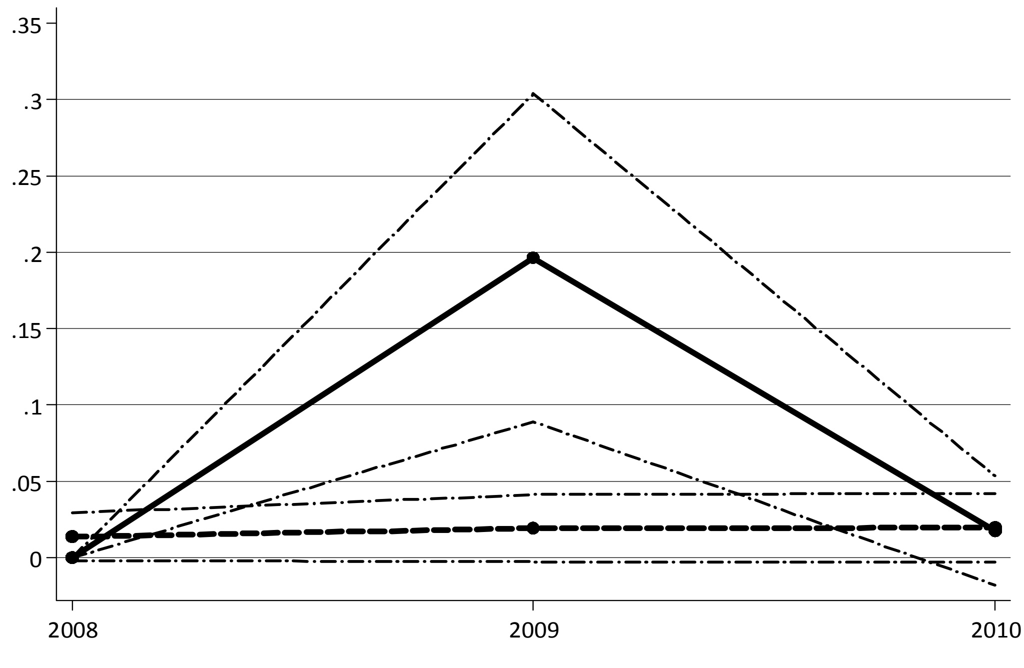
[20] For the livestock indicator to be one, the household must own at least one of the following: one bull/cow, at least eight ruminants, at least five donkeys or at least ten different animals, not including poultry.

[21] Clustering at a village level is not well founded, as some of the villages are very scattered and it is unclear if households that officially belong to village A, but reside nearer to the centre of another village B, face the same shocks as an average household in village A.

The results from the actual regression analysis are presented in Table 7. The first three columns display the results from the DD analysis, while the last three columns refer to the IV estimates. Recall that the IV estimates are approximately equal to the DD estimates divided by the share of the group members from village population. The models in columns (1), (2), (4) and (5) are pooled regressions accounting for year and village fixed effects while columns (3) and (6) include household fixed effects along with the year effects. The results suggest that the reform had a statistically significant positive impact on the propensity to use fertilizers, but only weekly so without the addition of control variables. The coefficient for *aid* increases between column (1) and (2) and (4) and (5) respectively, suggesting that the covariates are highly correlated with treatment status. However, it turns out that one single control variable, *rain*, is almost entirely responsible for the doubling of the coefficient for aid. When all other controls (apart from village and year dummies) are dropped, the coefficient for aid is 0.103. Given our IV estimations this is an encouraging result, since the covariates related to household characteristics are not correlated with treatment status. This supports our assumption that treatment is as good as randomly assigned.

Given that there is a drop in use of fertilizer in 2010, it is interesting to compare the effects if 2009 or 2010 are dropped. If 2010 is dropped, so that results are measured only one year into the intervention, the coefficient on aid is twice the size (0.115) compared to the pooled regression without the addition of control variables. But when controls are added the effect diminishes (0.108) and the results compared to the pooled regression are not dramatic anymore. If the results between the baseline year and 2010 are measured so that 2009 is dropped, the coefficient is close to zero, and the effects of aid are, thus, only statistically significant during the first year.

Figure 3: The share of farmers using fertilizers

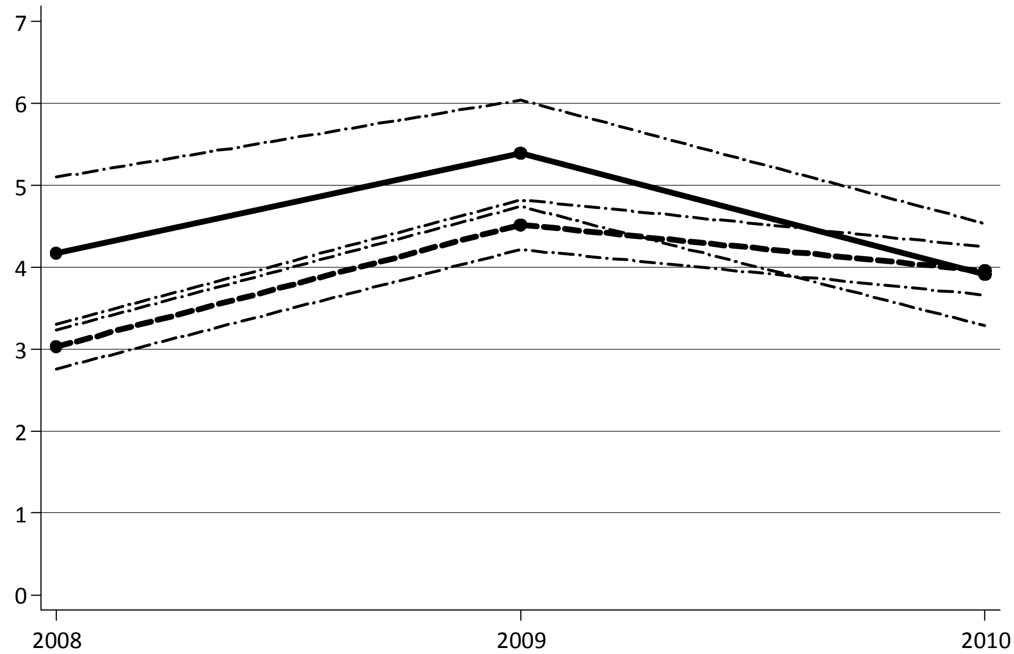


Note: The solid upper line refers to the mean amongst the group members and the lower, thicker, dashed line to households living in the control villages. The thin dashed lines depict the 95 per cent confidence intervals.
Source: authors' illustration.

Figure 4 reports an increase in the number of crops in 2009 but a drop again in 2010. A drop in the number of crop varieties from 2009-10 could also be a positive signal if farmers replaced old varieties with new ones. A simple decomposition shows, however, that the drop in the number of crops farmed in 2010 is concentrated on the ‘new plants’, i.e. those not farmed in 2008. The share of new plants farmed in 2010 was still 34 per cent, indicating that there has been a shift in farmers’ crop portfolios.

Table 8 shows the regression results of number of crops harvested. Aid enters with a positive sign but is not significant. While hectares in use increase the number of crops harvested, use of low land decreases the number of crops cultivated. As we showed in Section 4, use of low land becomes more common as rain fall decreases, and is especially common in 2010. In some sense the intervention and the climatic circumstances therefore could work in opposite directions. The intervention tries to identify the farmers to take new crops in use but at the same time drought makes farmers more inclined to reduce the number of crops that they cultivate.

Figure 4: The number of crops farmed



Note: The solid upper line refers to the mean among the group members and the lower, thicker, dashed line to households living in the control villages. The thin dashed lines depict the 95 per cent confidence intervals.
Source: authors’ illustration.

While the aid programme attempted to increase the number of crops farmed, the main goal was still to encourage the farmers to use new varieties of existing plants (mainly maize). The baseline questionnaire did not include a question on whether the crops farmed were traditional or improved variety, and therefore we are not able to carry out a DD analysis on this outcome. The question on the use of improved varieties of existing seeds was added to the questionnaires in 2009 and 2010, and therefore we can make a cross-sectional comparison on the propensity to use improved varieties between households in treatment and control villages, controlling for the socioeconomic background of the households. More formally, we run estimations for the two post reform years, 2009 and 2010, of the form:

$$y_{i,v,t} = \alpha^3 + X_{i,t}\beta^2 + \sum \lambda_t^3 year_t + \delta^3 treat\_vil_{i,v,t} + \varepsilon_{i,v,t}^2 \ ,$$

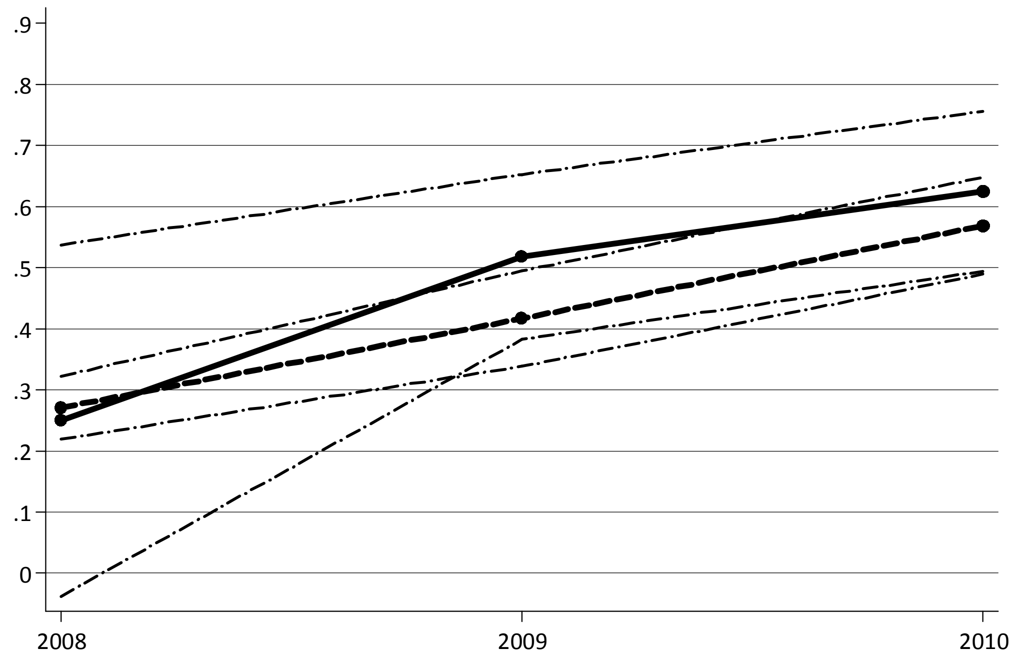
where the interesting variable is the dummy for living in the treatment villages. The IV estimations are otherwise similar, but there the idea is to look at the effect of group membership, and living in the treatment village is used as an instrument for group participation.

The results are reported in Table 9. The dependent variable is the number of improved varieties used, Column (1) and (2) report the OLS estimates and Column (3) and (4) the IV estimates. Both are significant and positive, suggesting that the reform had a positive impact on the use of improved varieties. This impact did not vanish in 2010. However, this evidence is weaker than that regarding fertilizer use since these regressions are not conducted in the DD framework.

6 Impact on food security and coping strategies

We now turn to the effects on food security and coping strategies. We use the indicators described in section 4 to measure food security: the 0/1 question on whether the households were able to have regular meals, the FCS and the CSI. The two latter are only available in 2009 and 2010. As we showed in Table 5 the ability to have regular meals is not highly correlated with the FCS. We use it here, however, since it is available for all the years.

Figure 5: The ability to have regular meals.



Note: The solid upper line refers to the mean amongst the group members, and the thicker dashed line to households living in the control villages. The thin dashed lines depict the 95 per cent confidence intervals.
Source: authors' calculations.

Figure 5 shows how the ability to have regular meals goes up for the treatment households in 2009 and stays approximately the same in 2010. For the control households, however, the indicator increases fairly sharply in 2010 and a larger share of the control households report ability to have regular meals compared to the treatment households.

The regressions on the ability to have regular meals reported in Table 10 indicate improvements in the treatment group, again noting that without controlling for rainfall the results would not be statistically significant. The rainfall variable alone explains the increase in the coefficient of the treatment variable when controls are added to the model. Additional analysis reveals that the impact of aid on the ability to have regular meals remains significant also in 2010. As expected since being an important wealth indicator, the number of TLUs owned by the household is also positive and highly significant in the pooled regressions. Owning livestock enters positively and the size of the household negatively in the pooled regressions. In the fixed effects regression in column 3 we note that switching to low land improves the ability to have regular meals. This is logical as an important way for households to cope with drought is to switch from high to low land (if they have access to both). In the IV regression in column 5, the coefficient for those that diversify land use at the same time is negative and significant.

We then study changes in the FCS. As noted in Table 11, while those in the treatment villages have higher FCS conditional on the control variables, the intervention did not have any significant impact on the FCS compared to the control group. Both the livelihood indicator on whether or not the household owns livestock and the wealth indicator on the number of TLUs owned by the household are positive and significant. Also literacy status of the household head enters positively and is weakly significant. Those that diversify land use in the same year have a significantly lower FCS.[22] The results are perhaps a bit disappointing but, as explained in Section 4 not necessarily surprising as food consumption habits are unlikely to change in the short term among vulnerable households in areas where production, access and utilisation is poor.

In Table 12 we turn to the CSI. The higher the CSI is the more negative copying strategies are, so here a negative coefficient entails a positive effect. In this Table we exceptionally use dependency ratio[23] instead of household size and number of children as it has higher explanatory power. We note that even without controls the treatment variable is weakly significant.[24] Literacy and ownership of livestock lower the score as well as the number of TLUs. A high dependency ratio and ill members in the household give a higher score (the former is on the edge of being weakly significant). Those that diversify the land they cultivate at the same time have significantly higher CSI and the change in the coefficient is remarkable. A closer inspection of the data confirms that this is not related to outliers or specific villages: regardless of the village the CSI is higher for those that cultivate on both types of land at the same time.

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[22] To some extent the chosen land type might also be a result of the programme itself. However, since the treatment effect remains relatively intact when controls are added, this is not a serious concern.

[23] Ratio of children+elderly to adults.

[24] This effect is statistically significant in both years.

7 Selection into the programme, spill-over and heterogeneous effects

7.1 Selection and spill-over

In this section we go beyond average treatment effects and study spill-over effects and heterogeneous effects within the programme villages. To study spill-over effects, we first have to try to identify an instrument that explains selection into the farming groups within the treatment villages but that can be excluded from the outcome equation. The only reasonable instrument available is the distance from the household to the centre of the village (where the farming groups took place). Whether this is a truly exogenous instrument is debatable. Households that are located further from the village centre might have characteristics that affect the outcome directly. Whether the conditional independence assumption (CIA)[25] holds and the regression can be given a causal interpretation is therefore questionable. But at least it will give us a sense of what is important for selection and if there are any indications of spill-over on people living in the programme villages but not participating in the farming groups.

When adding the distance variable to the outcome regressions, the coefficients are minor and the variable enters with hardly any significance.

Our approach is similar to Jansen (2005) and estimates an equation of the form:

$$y_{i,v,t} = \alpha^5 + X_{i,t}\beta^5 + \sum \lambda_t^5 year_t + \sum \phi_v^5 village_v + \gamma^5 T_{i,v,t}\, \hat{m}_{i,v,t} + \delta^5 T_{i,v,t} + \varepsilon_{i,v,t}^5$$

where $\hat{m}_{i,v,t}$ refers to those who are members of a farmer group and $T_{i,v,t}$ to those who have access to treatment (*treatment village* treatment year)*, that is, the term of interest in our previous specification. This specification allows us to estimate the effect of participation versus non-participation in farmer groups and of living in a programme village versus a control village. The estimate for γ^5 is the effect of participating versus not when being under treatment. The estimate for δ^5 captures the difference between living in a programme village and living in a treatment village during the period when treatment is on-going. In other words this captures potential spill-over effects or effects from village level treatment activities in addition to the farmer groups. It is important to note that when distance is used as the instrument rather than change in policy regime as above (introduction of the aid intervention), the treatment estimate does not lend itself to the LATE interpretation anymore. We therefore have to assume that participation treatment heterogeneity is negligible and interpret γ^5 as the average treatment effect of participation.

This equation is estimated using 2SLS where the first stage accounts for selection bias into farmer groups and reflects the participation decision. We estimate:

$$PR(m_{i,v,t} = 1) = \alpha^6 + X_{i,t}\beta^6 + \sum \lambda_t^6 year_t + \sum \gamma_v^2 village_v + \omega_i Z_i + \varepsilon_{i,v,t}^3 \; .$$

where Z_i contains the instrument not included in the second stage. This equation is estimated only for the households living in the treatment villages. The predicted participation variable is

25 The CIA holds when the instrument is as good as randomly assigned, conditional on covariates.

then used as an exogenous variable in the second stage and interacted with the treatment dummy.

Results from the first stage are reported in Table 13. We note that households are much less likely to participate in aid groups in Nongoti. This village is much more dispersed than Swiswi, but also after controlling for the distance from the household to the village center, the village dummy remains significant. The fact that the distance variable is negative and highly significant suggests that spatial factors are important in this context[26]. Households with female heads are more likely to participate in farming groups (expected as they are encouraged to do so), while single heads or widow heads are less likely to participate. Those that cultivate on high and low land at the same time are more likely to participate. The number of hectares a household uses enters positively and is on the edge of being significant in the selection regression on participation in farming groups.

We study spill-over effects on one of the immediate outcome variables: use of fertilizer and one food security variable: number of farming techniques used (since this is available for all years). The results in Table 14 show that no such spill-over effects can be picked up when it comes to these two variables. This is perhaps disappointing given the objectives of the project to reach results on the community level. It is not very surprising, however, given that the distance variable is negative and highly significant in the first stage. Spill-over effects are less likely to take place when households are dispersed and when those that live far away are the ones not participating.

7.2 Heterogeneous effects

Some preliminary indications of heterogeneous effects can either be shown by adding interaction terms between aid and certain characteristics in the regressions or by dividing the sample and running separate regressions based on certain characteristics. In the interaction terms we focus on variables that are related to potential vulnerability of the households: migration status of household head, whether a household member is ill, the equivalised number of hectares per household member[27] and if a household is headed by a female.

Results based on the first strategy are shown in Table 15 for fertilizers and number of techniques used. The latter variable includes use of labour on their fields, whether or not the household bought seeds and whether they used manure, fertilizers or pesticides on their fields. We have used the same covariates as before but they are not shown in the table. Columns (1) and (5) display the original results from the pooled regressions. In column (2), we have added an interaction term between aid and migration status of head. The results suggest that when it comes to the fertilizer use, households with migrated heads benefit more from treatment than the average household. The coefficient of aid is smaller than the original coefficient and it is less significant. The coefficient of the interaction term between aid and migration status of household head is almost three times the size of the aid coefficient. In columns (3) and (4) we have added interaction terms on hectares and head status. The variable Aid*hectares enters negatively but the effect is not statistically significant. Female head status does not make a big difference. In column (4) we have added an interaction term between aid and illness. In the original regression, aid did not have a significant effect on the number of techniques used. But when the interaction term is added the results change as ill

[26] In an analysis of the error terms, we did not find any evidence for spatial autocorrelation however.

[27] We equivalise the hectares by using the square root of household size.

people benefit less from aid than the average household. In fact they do not benefit at all as the coefficient of the interaction term is negative. A similar story can be told when hectares are interacted with aid. Again, head being female does not make any major difference.

In Table 16 we look at the CSI based on whether the household has livestock or not. Column (1) reports the original IV regression, while the regression with those *with* livestock is reported in column (2) and those *with no* livestock in column (3). The results are fairly remarkable. For households with livestock, participating in a farming aid group has no significant impact on the CSI. For households without livestock, the treatment variable is negative (here indicating a positive effect) and highly significant. The same results are shown in column (4) but with an interaction term between aid and livestock ownership[28].

The analysis above gives some indications that the most vulnerable households benefit from the project, since households with a migrated head and households without livestock appear to have benefitted more from aid.

8 Conclusion

This paper examined the efficiency of a farming development project in rural Mozambique using household-level panel data from treatment and control villages before and after the intervention. The aid project concentrated on improving the livelihoods of poor farmers via adoption of new varieties of existing seeds and improved technology, most notably fertilizers. One feature of the intervention was its bottom-up design: it was based on the villagers' own discussion on village development and especially setting up farmers' groups, which received support from the NGO managing the aid. The project is also interesting because it focused on improving farming practices among self-sufficient farmers, many of whom are poor women, making the evidence reported in this paper also relevant for the analysis of women's empowerment.

We used two types of empirical approaches to evaluate the impacts of this new type of aid. First, a difference-in-difference analysis was conducted to measure 'the intention to treat' effect, i.e. the effect of living in the villages receiving aid after the intervention. While this DD estimate can capture potential spillover effects to those who remain outside of the groups, it is also likely to underestimate the impact of aid on those who actually take up the aid. To measure this effect, we also used an IV analysis where eligibility for aid was used as an instrument for participating in the farmers' groups. Finally we explicitly studied spill-overs and heterogeneous effects.

The results reveal that there were some immediate gains from the aid intervention. Fertilizer use increased by 20 per cent among programme participants and the participating households used almost one new improved variety of seeds. The results related to households' livelihoods are mixed: while food consumption scores did not improve, the participating households moved to use more sustainable coping strategies. However, the effectiveness of the programme on farming outcomes (but not for food security) declined during its second year. This can be due in some extent to a serious drought that also hit the treatment villages more severely than the control villages. In addition, there were delays in delivering the aid

[28] Recall that a household might own a small number of animals and still have livestock=0. That is why TLUs enter the regression.

after the first year of intervention. One of the lessons of the analysis is that obtaining permanent improvements in livelihoods in these adverse conditions probably requires constant and long-term presence of aid.

Our analysis revealed some interesting heterogeneous effects of aid. In some cases, particularly vulnerable households (those without livestock and with a migrated household member), benefitted more from the project (but the presence of illness in the family was negatively related with the impact of aid). Perhaps households with illness should have received more attention or other type of aid. Since we were unable to detect any significant spill-over effects, all results were confined to project participants. The last observation underlines the need to know more about the effectiveness of aid (and also this type of aid) over a longer period of time. That is a question for future research.

Appendix 1

Table 1: Project and control villages, sample size, attrition and farming group participation

	Project villages		Control villages			
	Swiswi	Nongoti	Saute	Nhanal	Queque	Solane
Total number of households in the village	36	121	97	340	279	31
Households interviewed (2008)	34	59	37	61	18	23
Households interviewed (2009)	31	53	33	58	17	20
Households interviewed (2010)	32	52	30	60	17	20
Farming intervention, group participation						
Village adoption rate to treatment, LWF 2009-10, %	89	46	-	-	-	-
Sample adoption rate to treatment, survey 2009, %	90	43	-	5	-	-
Sample adoption rate to treatment, survey 2010, %	66	32	-	10	-	-
Δ dropouts % (Δ newcomers %) 2009-10, %	35 (11)	61 (35)				
Other NGO operates in the village: farming development			no	caritas	no	no

Source: authors' calculations.

Table 2: Basic household and member characteristics in the baseline survey 2008

	Project villages	Control villages	Total	P value for difference between project and control villages
Number of households	92	140	232	
Household size				
Mean	6.3	6.3	6.3	0.956
Median	6.0	6.0	6.0	
Max	22	23	23	
Number of children age <15				
Mean	3.0	3.0	3.0	0.990
Median	3.0	3.0	3.0	
Max	9	11	11	
	%	%	%	
Female head	38	36	37	0.803
Head/spouse literate	30	37	34	0.293
Head migrated	13	12	13	0.839
Other members migrated	33	28	30	0.439
Ill member(s) in household	48	39	43	0.198
Marital status of head				
Married (monogamy)	45	44	44	0.919
Married (polygamy)	24	28	26	0.484
Divorced/separated	3	5	4	0.516
Widow/widower	26	18	21	0.140
Never married	2	5	4	0.271
Number of persons	581	880	1461	
Age				
Mean	23.0	21.7	22.3	0.248
Median	15.0	14.0	15.0	
	%	%	%	
Sex				
Male	44	45	45	0.643
Female	56	55	55	0.643

Source: authors' calculations.

Table 3: Water security 2008-10

	Project villages			Control villages			P value for difference between project and control villages		
Number of households	92			140					
	2008	2009	2010	2008	2009	2010	2008	2009	2010
Cumulative amount mm of rain in the rainy season (Nov-Apr)*	708	634	539	642	634	572			
Source of drinking water (%)									
Well with pump	36	18	37	13	16	30	0.000	0.783	0.327
Well without pump	63	57	45	76	71	58	0.033	0.037	0.062
River, spring, pond	0	25	15	10	11	8	0.002	0.007	0.090
Rain water	1	0	2	0	2	2	0.220	0.250	0.993
Other	0	0	0	1	0	1	0.413	-	0.411
Land type used for cultivation (%)									
High land	85	79	52	84	83	63	0.948	0.669	0.143
Low land	12	8	31	13	13	32	0.816	0.370	0.918
High land and low land	2	11	15	1	5	5	0.678	0.084	0.008

Source: authors' calculations.

Table 4: Farming and livestock in the baseline survey 2008

	Project villages	Control villages	P value for difference between project and control villages
Number of households	92	140	
Fields (hectares)			
Average size	3.51	3.87	0.384
Median sixe	3.00	3.00	
Five most common crops (%)			
Maize	99	100	0.646
Cow peas	83	86	0.850
Peanuts	73	55	0.004
Pumpkin	61	40	0.002
Water melon	44	37	0.256
Number of crops harvested (%)			
No crops	3	6	0.390
One crop	8	4	0.174
Two crops	4	24	0.000
3-4 crops	46	32	0.038
More than 5 crops	39	35	0.523
Livestock owned by households (% of households)			
Oxen/bulls and/or cows	35	42	0.261
Goats and sheep	41	64	0.001
Chicken and other poultry	71	73	0.714
No livestock	15	14	0.726
Tropical livestock units			
Average size	2.98	3.99	0.310
Median sixe	0.54	1.29	

Source: authors' calculations.

Table 5: FCS, CSI and ability to have regular meals by FCS classification, 2009

	Project villages	Control villages	P-value for difference between project and control villages
Number of households	84	128	
FCS average	29.54	28.53	0.573
CSI average	11.18	15.07	0.049
% of households in each FCS category			
Poor	30	34	0.486
Borderline	38	38	0.931
Acceptable	32	28	0.533
Average CSI by FCS category			
Poor	18.5	18.5	0.990
Borderline	9.4	15.7	0.036
Acceptable	6.6	10.0	0.167
% of households able to have regular meals by FCS category			
Poor	32.0	36.4	0.719
Borderline	59.4	45.8	0.241
Acceptable	48.1	44.4	0.775
Average TLU by FCS category			
Poor	1.7	2.9	0.190
Borderline	4.7	5.6	0.700
Acceptable	5.2	4.9	0.843

Source: authors' calculations.

Table 6: Coping strategies used to feed the household, 2009

	Project villages	Control villages	Severity weight
	%	%	
Rely on less preferred and less expensive food	79.5	84.2	1
Limit portion sizes	74.4	67.5	1
Gather wild food, hunt or harvest immature crops	52.6	58.3	2
Consume seed stock held for next season	41.0	55.0	2
Restrict adult cons so that children can eat	28.2	40.0	3
Borrow food or rely on help from a friend or a relative	26.9	34.2	2
Feed working hh members on the expense of non-working members	9.0	6.7	2
Send household members to beg	6.4	5.0	3

Source: authors' calculations.

Table 7: Use of fertilizer

VARIABLES	(1)	(2)	(3) Fixed effects	(4) IV	(5) IV	(6) Fixed effects IV
Aid	0.0547*	0.0887**	0.0772*			
	(0.0327)	(0.0403)	(0.0440)			
Aid group				0.1262*	0.2067**	0.1939*
				(0.0759)	(0.0998)	(0.1135)
2009	0.0315***	0.0223**	0.0205	0.0263***	0.0153	0.0052
	(0.0103)	(0.0109)	(0.0140)	(0.0098)	(0.0107)	(0.0285)
2010	-0.0168	0.0035	0.0024	-0.0219*	-0.0021	-0.0083
	(0.0104)	(0.0105)	(0.0092)	(0.0127)	(0.0137)	(0.0283)
Village: Nongoti	-0.1137***	-0.0895***		-0.0768*	-0.0324	
	(0.0361)	(0.0318)		(0.0425)	(0.0423)	
Village: Nhanal	-0.0977***	-0.0347		-0.0734*	0.0015	
	(0.0333)	(0.0315)		(0.0416)	(0.0475)	
Village: Queque	-0.1086***	-0.0435		-0.0875**	-0.0149	
	(0.0332)	(0.0318)		(0.0407)	(0.0442)	
Village: Solane	-0.1097***	-0.0693**		-0.0826*	-0.0319	
	(0.0332)	(0.0291)		(0.0428)	(0.0421)	
Village: Saute	-0.1097***	-0.0731**		-0.0877**	-0.0392	
	(0.0332)	(0.0313)		(0.0410)	(0.0443)	
Household size		-0.0040	-0.0015		-0.0047*	0.0023
		(0.0026)	(0.0057)		(0.0028)	(0.0091)
Number of children		0.0030	0.0009		0.0033	0.0063
		(0.0032)	(0.0054)		(0.0036)	(0.0124)
Female head		0.0076	0.0503*		-0.0037	0.0370
		(0.0371)	(0.0298)		(0.0394)	(0.0648)
Head/spouse literate		0.0180	-0.0212		0.0071	-0.0317
		(0.0150)	(0.0405)		(0.0147)	(0.0505)
Marital st head: polygamy		-0.0095	0.0173		-0.0025	0.0168
		(0.0146)	(0.0394)		(0.0160)	(0.0469)
Marital st head: single		0.0122	0.0153		0.0251	0.0358
		(0.0366)	(0.0296)		(0.0372)	(0.0904)

Marital st head: widow		0.0095		-0.0653**		0.0326	-0.0136
		(0.0442)		(0.0321)		(0.0476)	(0.0708)
Head migrated		0.0501		0.0571		0.0703*	0.0693
		(0.0385)		(0.0452)		(0.0425)	(0.0743)
Ill member in hh		-0.0143	-0.0221		-0.0133	-0.0182	
		(0.0130)	(0.0147)		(0.0134)	(0.0192)	
Hh owns livestock		0.0140	0.0375		0.0247	0.0454	
		(0.0195)	(0.0298)		(0.0200)	(0.0287)	
Tropical livestock units		0.0011	0.0013		0.0017	0.0013	
		(0.0017)	(0.0026)		(0.0017)	(0.0024)	
N of hectares		0.0030	0.0045		0.0024	0.0038	
		(0.0031)	(0.0037)		(0.0031)	(0.0029)	
Rain		0.0004**	0.0003*		0.0004*	0.0004	
		(0.0002)	(0.0002)		(0.0002)	(0.0003)	
Fields: low land		0.0094	0.0114		0.0040	-0.0007	
		(0.0177)	(0.0215)		(0.0187)	(0.0248)	
Fields: high and low land		0.0681	0.0239		0.0496	0.0116	
		(0.0612)	(0.0760)		(0.0654)	(0.0397)	
Observations	650	642	642	650	641	641	
R-squared	0.0982	0.1230	0.0787	0.0588			
Number of hhcode			240			239	

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Table 8: Number of crops harvested

VARIABLES	(1)	(2)	(3) Fixed effects	(4) IV	(5) IV	(6) Fixed effects IV
Aid	0.3288	0.4079	0.5010			
	(0.3249)	(0.4992)	(0.4883)			
Aid group				0.7591	0.8691	1.1773
				(0.7306)	(1.1311)	(1.2760)
2009	0.6429***	0.4939**	0.4491*	0.6119**	0.4740*	0.3637
	(0.2089)	(0.2280)	(0.2351)	(0.2403)	(0.2555)	(0.3184)
2010	-0.1669	-0.1840	-0.1765	-0.1978	-0.2099	-0.2563
	(0.2074)	(0.2304)	(0.2585)	(0.2458)	(0.2398)	(0.3223)
Village: Nongoti	-0.5749**	-0.6449**		-0.3530	-0.3524	
	(0.2542)	(0.2654)		(0.3352)	(0.4077)	
Village: Nhanal	-0.6615**	-0.6347		-0.5149	-0.4548	
	(0.3053)	(0.4703)		(0.4166)	(0.6308)	
Village: Queque	-0.6652*	-0.7871		-0.5368	-0.5952	
	(0.3976)	(0.5590)		(0.4556)	(0.6586)	
Village: Solane	-0.5835*	-0.8098**		-0.4204	-0.5834	
	(0.3260)	(0.4019)		(0.4718)	(0.5767)	
Village: Saute	-0.3932	-0.3146		-0.2609	-0.1022	
	(0.3656)	(0.4241)		(0.4350)	(0.5559)	
Household size		0.0366	0.0760		0.0348	0.1011
		(0.0441)	(0.0950)		(0.0429)	(0.1017)
Number of children		0.0033	0.0272		-0.0005	0.0590
		(0.0626)	(0.1363)		(0.0593)	(0.1424)
Female head		0.3882	0.6678		0.3167	0.6011
		(0.2815)	(0.5662)		(0.2932)	(0.7422)
Head/spouse literate		0.3068*	-0.3689		0.2677	-0.4089
		(0.1745)	(0.4850)		(0.1892)	(0.5786)
Marital stat head: polygamy		-0.0729	0.7441		-0.0646	0.7412
		(0.2381)	(0.7433)		(0.2380)	(0.5379)
Marital stat head: single		-0.4685	-1.0103		-0.4461	-0.8453
		(0.3580)	(0.6976)		(0.3511)	(1.0365)
Marital stat head: widow		-0.4899	-0.5025		-0.3836	-0.1923
		(0.3249)	(0.6755)		(0.3363)	(0.8078)
Head migrated		0.0605	-0.6526		0.1374	-0.6073
		(0.3222)	(0.6199)		(0.3529)	(0.8518)

Ill member in hh		-0.1241	-0.0609		-0.1327	-0.0407
		(0.1635)	(0.2238)		(0.1528)	(0.2181)
Hh owns livestock		0.0014	0.1085		0.0512	0.1499
		(0.1839)	(0.2989)		(0.1907)	(0.3254)
Tropical livestock units		-0.0080	-0.0007		-0.0029	0.0013
		(0.0119)	(0.0244)		(0.0114)	(0.0272)
N of hectares		0.0900***	0.0855**		0.0873***	0.0811**
		(0.0277)	(0.0414)		(0.0291)	(0.0328)
Rain		0.0006	0.0006		0.0005	0.0005
		(0.0032)	(0.0033)		(0.0031)	(0.0036)
Fields: low land		-0.4255**	-0.5748**		-0.4517**	-0.6517**
		(0.2089)	(0.2640)		(0.1976)	(0.2834)
Fields: high and low land		-0.0423	0.1506		-0.1216	0.0881
		(0.4472)	(0.5784)		(0.4077)	(0.4544)
Observations	653	645	645	653	644	644
R-squared	0.0567	0.1243	0.1080	0.0423	0.1045	
Number of hhcode			240			239

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

Source: authors' calculations.

Table 9: Number of improved varieties used

VARIABLES	(1)	(2)	(3) IV	(4) IV
Aid	0.2450**	0.2899**		
	(0.1127)	(0.1280)		
Aid group			0.5583**	0.6997**
			(0.2687)	(0.3375)
2010	0.0472	0.0983	0.0464	0.0877
	(0.1033)	(0.1450)	(0.1062)	(0.1467)
Household size		0.0108		0.0067
		(0.0250)		(0.0257)
Number of children		-0.0183		-0.0213
		(0.0390)		(0.0406)
Female head		0.0942		0.0920
		(0.1242)		(0.1363)
Head/spouse literate		0.1112		0.0858
		(0.1129)		(0.1139)
Marital stat head: polygamy		-0.1351		-0.0546
		(0.1818)		(0.1901)
Marital stat head: single		-0.1915		-0.1448
		(0.1557)		(0.1754)
Marital stat head: widow		-0.1727		-0.0877
		(0.1497)		(0.1630)
Head migrated		-0.0180		0.0639
		(0.1808)		(0.1927)
Ill member in hh		-0.1940**		-0.1722*
		(0.0918)		(0.1001)
Hh owns livestock		0.3586***		0.4009***
		(0.1379)		(0.1473)
Tropical livestock units		0.0021		0.0047
		(0.0150)		(0.0132)
N of hectares		-0.0222*		-0.0248**
		(0.0118)		(0.0126)
Rain		0.0013		0.0010
		(0.0019)		(0.0019)

Fields: low land		-0.0111		-0.0479
		(0.1277)		(0.1361)
Fields: high and low land		-0.0880		-0.1894
		(0.2053)		(0.2080)
Observations	421	418	421	418
R-squared	0.0132	0.0646		

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Table 10: Ability to have regular meals

VARIABLES	(1)	(2)	(3) Fixed effects	(4) IV	(5) IV	(6) Fixed effects IV
Aid	0.0912	0.359***	0.3615***			
	(0.0767)	(0.118)	(0.1238)			
Aid group				0.2105	0.8552***	0.9325***
				(0.1702)	(0.2892)	(0.3442)
Village: Nongoti	0.0572	0.0121	0.0245	0.0486	-0.0182	-0.0445
	(0.0576)	(0.0622)	(0.0670)	(0.0614)	(0.0700)	(0.0847)
Village: Nhanal	0.1961***	0.313***	0.3134***	0.1876***	0.2906***	0.2692***
	(0.0531)	(0.0723)	(0.0801)	(0.0566)	(0.0693)	(0.0819)
Village: Queque	0.0852	0.0771		0.1467**	0.2988***	
	(0.0672)	(0.0719)		(0.0735)	(0.1013)	
Village: Solane	0.2150***	0.465***		0.2557***	0.6067***	
	(0.0762)	(0.118)		(0.0964)	(0.1661)	
Village: Saute	0.1883*	0.421***		0.2239**	0.5217***	
	(0.1008)	(0.133)		(0.1125)	(0.1624)	
2009	0.1207	0.180*		0.1659	0.3149**	
	(0.0955)	(0.107)		(0.1123)	(0.1396)	
2010	0.0934	0.250**		0.1301	0.3704**	
	(0.0855)	(0.103)		(0.1021)	(0.1454)	
Household size		-0.0163*	-0.0005		-0.0196**	0.0136
		(0.00862)	(0.0236)		(0.0084)	(0.0287)
Number of children		0.00515	-0.0364		0.0078	-0.0075
		(0.0145)	(0.0325)		(0.0156)	(0.0387)
Female head		-0.00394	0.2701		-0.0434	0.1977
		(0.0714)	(0.1874)		(0.0716)	(0.1638)
Head/spouse literate		-0.0324	-0.1604		-0.0797	-0.2235
		(0.0412)	(0.1274)		(0.0486)	(0.1610)
Marital stat head: polygamy		0.00446	0.0453		0.0396	0.0440
		(0.0533)	(0.1314)		(0.0597)	(0.1501)
Marital stat head: single		-0.0751	0.0649		-0.0140	0.1358
		(0.0769)	(0.2270)		(0.0785)	(0.1987)
Marital stat head: widow		-0.0470	-0.1297		0.0442	0.1189
		(0.0796)	(0.1507)		(0.0853)	(0.1693)
Head migrated		0.0496	-0.2463		0.1347	-0.1719
		(0.0844)	(0.2150)		(0.0895)	(0.1927)

Ill member in hh		-0.0134	-0.0608		-0.0061	-0.0426
		(0.0385)	(0.0532)		(0.0434)	(0.0623)
Hh owns livestock		0.101**	-0.0226		0.1440***	0.0115
		(0.0460)	(0.0791)		(0.0519)	(0.0870)
Tropical livestock units		0.00797***	0.0057		0.0098***	0.0040
		(0.00224)	(0.0052)		(0.0031)	(0.0069)
N of hectares		0.00715	0.0112		0.0047	0.0073
		(0.00590)	(0.0082)		(0.0060)	(0.0083)
Rain		0.00252***	0.0025***		0.0025***	0.0027***
		(0.000871)	(0.0009)		(0.0009)	(0.0010)
Fields: low land		0.0784	0.1393**		0.0563	0.0855
		(0.0561)	(0.0684)		(0.0619)	(0.0793)
Fields: high and low land		-0.119	-0.1336		-0.1948**	-0.1985
		(0.0971)	(0.1173)		(0.0990)	(0.1305)
Observations	653	645	645	653	644	621
R-squared	0.0517	0.110	0.1157	0.0533		
Number of hhcode			240			216

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

Source: authors' calculations.

Table 11: Food consumption score

VARIABLES	(1)	(2)	(3) IV	(4) IV
Aid	0.488	1.873		
	(1.297)	(1.367)		
Aid group			1.111	4.294
			(2.945)	(3.349)
2010	-0.418	0.451	-0.419	0.379
	(1.269)	(2.454)	(1.262)	(2.384)
Household size		0.250		0.226
		(0.324)		(0.313)
Number of children		-0.436		-0.462
		(0.501)		(0.481)
Female head		-0.417		-0.490
		(2.140)		(2.123)
Head/spouse literate		2.453*		2.304*
		(1.461)		(1.394)
Marital stat head: polygamy		0.434		0.885
		(1.896)		(2.004)
Marital stat head: single		0.830		1.077
		(2.493)		(2.496)
Marital stat head: widow		0.775		1.313
		(2.215)		(2.187)
Head migrated		0.679		1.196
		(2.451)		(2.387)
Ill member in hh		-0.540		-0.439
		(1.285)		(1.258)
Hh owns livestock		3.705**		3.937**
		(1.563)		(1.552)
Tropical livestock units		0.266***		0.288***
		(0.0952)		(0.0927)
N of hectares		-0.127		-0.142
		(0.161)		(0.155)
Rain		0.0207		0.0187
		(0.0272)		(0.0261)

Fields: low land		-1.069		-1.312
		(1.610)		(1.567)
Fields: high and low land		-4.715*		-5.348**
		(2.467)		(2.394)
Observations	421	418	421	418
R-squared	0.001	0.097	0.002	0.102

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

Source: authors' calculations.

Table 12: Coping strategy index

VARIABLES	(1)	(2)	(3) IV	(4) IV
Aid	-2.781*	-5.153***		
	(1.596)	(1.519)		
Aid group			-6.337*	-13.10***
			(3.703)	(3.995)
2010	3.980***	2.429	3.989***	2.583
	(1.465)	(2.809)	(1.460)	(2.749)
Dependency ratio		1.135		1.204
		(0.761)		(0.766)
Female head		1.631		1.627
		(3.301)		(3.356)
Head/spouse literate		-3.549**		-3.029*
		(1.642)		(1.652)
Marital stat head: polygamy		1.692		0.469
		(1.788)		(1.990)
Marital stat head: single		0.155		-1.039
		(3.326)		(3.642)
Marital stat head: widow		1.537		-0.137
		(3.696)		(3.703)
Head migrated		0.790		-0.866
		(3.540)		(3.618)
Ill member in hh		5.481***		5.007***
		(1.440)		(1.492)
Hh owns livestock		-3.647**		-4.429**
		(1.694)		(1.728)
Tropical livestock units		-0.135*		-0.151**
		(0.0755)		(0.0674)
N of hectares		-0.297		-0.234
		(0.219)		(0.219)
Rain		-0.0371		-0.0323
		(0.0297)		(0.0289)
Fields: low land		-1.061		-0.397
		(1.893)		(2.039)
Fields: high and low land		14.74***		16.58***
		(3.260)		(3.054)
Observations	421	418	421	418
R-squared	0.023	0.192	0.003	0.119

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

Source: authors' calculations.

Table 13: Selection into farming groups in the treatment villages

VARIABLES	(1) Probit (marginal effects)
Nongoti	0.140**
	(0.0653)
2010	-0.245***
	(0.0740)
Household size	-0.00916
	(0.0135)
Number of children	0.00307
	(0.0243)
Female head	0.194*
	(0.107)
Head/spouse literate	-0.0549
	(0.0830)
Marital stat head: polygamy	-0.0172
	(0.110)
Marital stat head: single	-0.362***
	(0.130)
Marital stat head: widow	-0.286**
	(0.126)
Head migrated	-0.153
	(0.110)
Ill member in hh	-0.140**
	(0.0699)
Hh owns livestock	-0.115
	(0.0809)
Tropical livestock units	-0.00833
	(0.00540)
N of hectares	0.0206*
	(0.0125)
Rain	-0.0427
	(0.0938)
Fields: low land	0.239**
	(0.112)

Distance to village centre	-0.0403***
	(0.0119)
Pseudo R-squared	0.255
Observations	165

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Table 14: Spill-over effects

VARIABLES	(1) Fertilizer	(2) Regular meals
Treated (γ^5)	0.1599*	0.3687**
	(0.0843)	(0.1603)
Aid (δ^5)	-0.0019	0.1487
	(0.0408)	(0.1540)
2009	0.0187*	0.0040
	(0.0103)	(0.0625)
2010	0.0044	0.3149***
	(0.0105)	(0.0722)
Village: Nongoti	-0.0503	0.1668**
	(0.0318)	(0.0830)
Village: Nhanal	-0.0187	0.5011***
	(0.0349)	(0.1186)
Village: Queque	-0.0263	0.4604***
	(0.0350)	(0.1336)
Village: Solane	-0.0475	0.2293**
	(0.0324)	(0.1074)
Village: Saute	-0.0525	0.2965***
	(0.0358)	(0.1032)
Household size	-0.0034	-0.0149*
	(0.0025)	(0.0085)
Number of children	0.0027	0.0045
	(0.0032)	(0.0146)
Female head	-0.0040	-0.0322
	(0.0374)	(0.0736)
Head/spouse literate	0.0183	-0.0316
	(0.0148)	(0.0410)
Marital stat head: polygamy	-0.0101	0.0032
	(0.0141)	(0.0534)
Marital stat head: single	0.0293	-0.0345
	(0.0373)	(0.0777)
Marital stat head: widow	0.0273	-0.0044
	(0.0451)	(0.0837)
Head migrated	0.0632	0.0812
	(0.0401)	(0.0849)

Ill member in hh	-0.0104	-0.0048
	(0.0119)	(0.0390)
Hh owns livestock	0.0195	0.1136**
	(0.0196)	(0.0462)
Tropical livestock units	0.0014	0.0086***
	(0.0017)	(0.0024)
N of hectares	0.0020	0.0050
	(0.0030)	(0.0060)
Rain	0.0003*	0.0024***
	(0.0002)	(0.0009)
Fields: low land	0.0100	0.0804
	(0.0177)	(0.0565)
Fields: high and low land	0.0514	-0.1574*
	(0.0631)	(0.0934)
Observations	641	644
R-squared	0.1330	0.1153

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Table 15: Heterogeneous effects with interaction terms

VARIABLES	(1) Fertilizer	(2) Fertilizer	(3) Fertilizer	(4) Fertilizer	(5) N of techniques	(6) N of techniques	(7) N of techniques	(8) N of techniques
Aid	0.0887**	0.0676*	0.122**	0.0729*	0.285	0.400**	0.356*	0.250
	(0.0403)	(0.0388)	(0.0546)	(0.0437)	(0.179)	(0.188)	(0.206)	(0.190)
Aid*head migrated		0.185**						
		(0.0862)						
Aid*hectares (eq)			-0.0659				-0.141	
			(0.0479)				(0.139)	
Aid*female head				0.0424				0.0936
				(0.0491)				(0.152)
Aid*ill hh member						-0.223		
						(0.138)		
Observations	642	642	642	642	645	645	645	645
R-squared	0.123	0.146	0.131	0.126	0.132	0.137	0.134	0.133

Notes: Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Table 16: Heterogeneous effects, CSI

VARIABLES	(1) IV	(2) IV If livestock=1	(3) IV If livestock=0	(4) IV
Aid group	-13.10***	-3.514	-19.46***	-22.97***
	(3.995)	(5.910)	(5.362)	(7.666)
2010	2.583	2.576	3.473	2.109
	(2.749)	(3.252)	(4.836)	(2.759)
Dependency ratio	1.204	-0.677	2.997**	1.270
	(0.766)	(0.677)	(1.180)	(0.823)
Female head	1.627	-4.577	2.325	1.843
	(3.356)	(6.192)	(3.735)	(3.511)
Head/spouse literate	-3.029*	-3.124*	-4.972*	-3.526**
	(1.652)	(1.898)	(3.000)	(1.736)
Marital stat head: polygamy	0.469	2.247	-1.184	0.571
	(1.990)	(2.067)	(4.265)	(1.885)
Marital stat head: single	-1.039	-3.510	-0.0400	-0.837
	(3.642)	(3.554)	(4.661)	(3.860)
Marital stat head: widow	-0.137	7.406	-2.715	-0.898
	(3.703)	(6.702)	(4.073)	(3.915)
Head migrated	-0.866	7.008	-5.129	-2.105
	(3.618)	(7.690)	(3.636)	(3.894)
Ill member in hh	5.007***	4.119*	7.823***	5.806***
	(1.492)	(2.155)	(2.458)	(1.600)
Hh owns livestock	-4.429**			-10.17***
	(1.728)			(3.155)
Tropical livestock units	-0.151**	-0.177***	-1.321	-0.116*
	(0.0674)	(0.0652)	(4.386)	(0.0683)
N of hectares	-0.234	-0.228	-0.186	-0.139
	(0.219)	(0.246)	(0.513)	(0.228)
Rain	-0.0323	-0.0531	-0.00979	-0.0413
	(0.0289)	(0.0325)	(0.0513)	(0.0299)
Fields: low land	-0.397	-2.798	0.636	-0.00119
	(2.039)	(2.364)	(3.272)	(2.092)
Fields: high and low land	16.58***	12.36***	18.45***	15.30***
	(3.054)	(3.922)	(4.787)	(3.292)
Aid*livestock				20.05**
				(7.979)
Observations				
R-squared	418	227	191	418

Notes: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: authors' calculations.

Appendix 2

Food consumption score (FCS). Based on question on consumption of the food items listed below during the seven past days.

Food items	Food group	Weight	Max. freq.	Max. points
Maize, rice, sorghum, millet, bread and other cereals Cassava, potatoes and sweet potatoes	Cereals and tubers	2	7	14
Beans (butter/soya), peas, cow peas, groundnuts, peanuts and cashew nuts	Pulses	3	7	21
Vegetables, relish and leaves	Vegetables	1	7	7
Fruits	Fruits	1	7	7
Beef, goat, poultry, pork, eggs and fish	Meat and fish	4	7	28
Milk and other dairy products	Milk	4	7	28
Sugar and sugar products	Sugar	0,5	7	3,5
Oils, fats and butter	Oil	0,5	7	3,5
Max. possible score				112

Note: Cut-off points: 0-21 poor, 22-35 borderline, >35 acceptable.
Source: based on data from World Food Programme (2009).

Coping strategy index (CSI). Based on the question: In the **past month**, as a result of not having enough food, how often has your household had to:

Coping strategy:	All the time/every day	Fairly often/3-6 times per week	Occasionally /1-2 times per week	Rarely/ less than once a week	Never	Severity weight
rely on less preferred and less expensive food?						1
borrow food or rely on help from a friend or relative?						2
gather wild food, hunt or harvest immature crops?						3
consume seed stock held for next season?						3
send household members to beg?						3
limit portion sizes?						1
restrict adult consumption so that children can eat?						3
feed working household members at the expense of non-working members?						2
Frequency weight	7	4,5	1,5	0,5	0	

Source: based on data from World Food Programme (2009).

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