Annemie Maertens
Wezi Mhango
Hope Michelson

The effect of demonstration plots and the warehouse receipt system on integrated soil fertility management adoption, yield and income of smallholder farmers

A study from Malawi's Anchor Farms

July 2020

Impact Evaluation Report 122

Agriculture, fishing and forestry

International Initiative for Impact Evaluation

About 3ie

The International Initiative for Impact Evaluation (3ie) promotes evidence-informed, equitable, inclusive and sustainable development. We support the generation and effective use of high-quality evidence to inform decision-making and improve the lives of people living in poverty in low- and middle-income countries. We provide guidance and support to produce, synthesise and quality assure evidence of what works, for whom, how, why and at what cost.

3ie impact evaluations

3ie-supported impact evaluations assess the difference a development intervention has made to social and economic outcomes. 3ie is committed to funding rigorous evaluations that include a theory-based design and that use the most appropriate mix of methods to capture outcomes and are useful in complex development contexts.

About this report

3ie accepted the final version of the report, *The effect of demonstration plots and the warehouse receipt system on integrated soil fertility management adoption, yield and income of smallholder farmers: a study from Malawi's Anchor Farms*, as partial fulfilment of requirements under grant TW4.1018 awarded through Agricultural Innovation Evidence Programme. The report is technically sound and 3ie is making it available to the public in this final report version as it was received. No further work has been done.

The 3ie technical quality assurance team for this report comprises Mark Engelbert, Deeksha Ahuja, Diana Milena Lopez Avila, Sayak Khatua, Stuti Tripathi, an anonymous external impact evaluation design expert reviewer and an anonymous external sector expert reviewer, with overall technical supervision by Marie Gaarder. The 3ie editorial production team for this report comprises Anushruti Ganguly and Akarsh Gupta.

All of the content is the sole responsibility of the authors and does not represent the opinions of 3ie, its donors or its board of commissioners. Any errors and omissions are also the sole responsibility of the authors. All affiliations of the authors listed in the title page are those that were in effect at the time the report was accepted. Please direct any comments or queries to the corresponding author, Hope Michelson, at: hopecm@illinois.edu.

3ie received funding for the Agricultural Innovation Evidence Programme from Alliance for Green Revolution in Africa, the Bill & Melinda Gates Foundation, the International Fund for Agricultural Development and the UK Department for International Development. A complete listing of all of 3ie's donors is available on the 3ie website.

Suggested citation: Maertens, A, Mhango, W and Michelson, H, 2020. *The effect of demonstration plots and the warehouse receipt system on integrated soil fertility management adoption, yield and income of smallholder farmers: a study from Malawi's Anchor Farms*, 3ie Impact Evaluation Report 122. New Delhi: International Initiative for Impact Evaluation (3ie). Available at: https://doi.org/10.23846/TW4IE122

Cover photo: Marcel Crozet / ILO

The effect of demonstration plots and the warehouse receipt system on integrated soil fertility management adoption, yield and income of smallholder farmers: a study from Malawi's Anchor Farms

Annemie Maertens
University of Sussex

Wezi Mhango
Lilongwe University of Agriculture and Natural Resources

Hope Michelson
University of Illinois, Urbana–Champaign

Impact Evaluation Report 122

July 2020

International Initiative for Impact Evaluation

Acknowledgements

The principal investigators of the project are Prof. Hope Michelson, Dr. Annemie Maertens, Dr. Wezi Mhango, the late Prof. Ephraim Chirwa, Prof. Cheryl Palm and Prof. Chris Barrett. The authors recognise the contributions of all principal investigators to this report.

We thank the field team of Wadondo Consulting for collecting data and Eric Kaima and the late Prof. Ephraim Chirwa for supervising the data collection. We acknowledge excellent research support from Tsegay Teklelassie and Kwabena Krah. We acknowledge the input of the Austin Ngwira and the rest of the team at CDI. We are grateful to seminar participants at the AAEA meetings 2017, NEUDC 2017, 3IE-Delhi, 3IE-London, AGRA-Nairobi, the University of Gottingen and Virginia Tech for excellent comments and suggestions. All errors and mistakes are however, our own.

Executive summary

In this report we present the results of our research project, which we nicknamed ISFM-Malawi. In this project, we aim to support the Clinton Development Initiative (CDI) in their scale-up of the Anchor Farm Project (AFP). The AFP aims to increase smallholder farmers' incomes and productivity through the adoption of Integrated Soil Fertility and Management Practices (ISFM), a group of techniques designed to increase the fertility of soils. ISFM includes application of mineral fertilizers, incorporation of organic matter, adoption of agroforestry, crop rotation and intercropping with legumes (such as soy), and use of conservation agriculture practices. ISFM provides potential solutions to increasing smallholder productivity, but to date, little information exists on how to implement these solutions.

CDI approaches the problem of low adoption as follows: first, CDI disseminates production knowledge through the use of demonstration plots, farmer clubs, lead farmers and farmer field days; and second, CDI improves farmers' access to output markets. When we started this research study in 2014 CDI was operating in three districts in central Malawi. In the coming years, CDI plans to further expand their activities. In this research project we aimed to support this scale-up by providing critical evidence as to the effectiveness of these various components.

Our evaluation ran from 2014 until 2019, using a quasi-Randomized Controlled Trial (RCT), in which some villages, randomly selected, receive certain components of the AFP, while others do not. Using baseline, midline and endline surveys, we established the short- and medium-term impacts of these various AFP components. Specifically, we use the random assignment of 250 villages into (i) a control group and (ii) a treatment group. The villages in the treatment group were requested to form farmer clubs, CDI's preferred delivery method, and invited to participate in CDI's extension program activities. While all treatment clubs were invited to farmer field-days, only a subset of clubs were selected to set up farmer demonstration plots. This program ran for two years. In the fourth year of our evaluation, CDI rolled out their marketing treatment. Again, we created a control group and a treatment group, orthogonal to the other two treatment groups, and invited only farmers in the treatment group to participate.

We collected three rounds of data, in 2014, 2015 and in 2018. A unique feature of our panel dataset is that we not only follow households over time, but we also follow fields over time, i.e., each field received a unique ID at baseline, and we followed up on each field to monitor perceived and actual soil fertility, as well as inputs and outputs over time. Using the baseline and midline data, we find that farmers who participated in farmer-led demonstration plots learn about the production processes of ISFM technologies, including the type and amount of pesticide to be used on soy, and this learning leads to increased planned adoption. Farmers invited to attend field-days learn considerably less, and what they learn is conditional on the degree to which they are credit-constrained.

Using the baseline and endline data, we note that the marketing program did not have the intended effects, largely due to the fact that the uptake of the program remained very low. However, we present some evidence of unintended positive effects: as farmers await the implementation of the marketing program, they postpone sales, and fetch a higher price.

Contents

List of figures and tables

Abbreviations

CDI	Clinton Development Initiative
3IE	International Initiative for Impact Evaluation
AGRA	Alliance for a Green Revolution in Africa
EPA	Extension Planning Area
MDE	Minimum Detectable Effect
ISFM	Integrated Soil Fertility and Management (Technologies)
AFP	Anchor Farm Project
RCT	Randomized Controlled Trial

1. Introduction

Agriculture accounts for 35% of Malawi's GDP and employs 90% of the rural population (GOM, 2010). However, 50.7% of the population engaged in agriculture lives below the poverty line (NSO, 2012). Agricultural extension can play a crucial role increasing yields and income, by helping farmers to overcome information constraints (Birkhaeuser et al. 1991, Picclotto and Anderson 1997, Feder et al. 1999, Anderson and Feder 2007, Davis 2008, Birner et al. 2009, Waddington and White 2014). Supporting and enhancing cost-effective agricultural extension systems is especially important in developing countries where the economy centres on agriculture, such as Malawi. As information is commonly non-rival and non-excludable, primary responsibility for developing and disseminating agricultural education programs falls to governments, especially at the start of diffusion processes where private sector operations are unable or unwilling to perform these services. Where responsibility resides with government extension services, effectiveness can vary. Birkhauser et al. (1991) reports rates of return ranging from negative to over 100 percent (see also IEG 2011, Anderson and Feder 2007 and for an overview of evaluations set in Malawi: Ragasa and Mazunda 2018).

A share of the variability in extension effectiveness may be attributable to the range of extension models employed, from systems in which extension agents visit and train lead farmers, to farmer-led demonstration plots where farmers experiment with a new technology under the guidance of an extension agent, and field-days in which farmers learn about technologies on-site for a single day (see Anderson et al. 2006). Such extension models not only range widely in terms of time and expense to both farmers and implementing agencies, but also have different implications for farmer learning and hence might result in different adoption patterns. However, to date, our understanding of these various extension systems is limited.

The literature on agricultural extension struggles with two primary empirical challenges. First, farmers who seek out and receive extension services might be more skilled and motivated than farmers who do not seek such services. Moreover, areas that attract extension services are also often areas with better agronomic potential. Because such factors are often unobserved by researchers, they can cause omitted variable bias, threatening the causal interpretation of estimated parameters. A second challenge is that although an extension

program may be successful in terms of knowledge diffusion, adoption among farmers may be influenced by other factors (market failures, logistical challenges, etc.); and learning may not always translate into adoption. As standard household surveys often do not detail the learning process, studies have often faced challenges discerning whether such failures reside in the education process itself, or in other circumstances down the line.

Understanding the learning and adoption processes of farmers is of utmost importance. The technologies being introduced to farmers can be complex, multi-dimensional and difficult to learn. Integrated Soil Fertility Management Practices (ISFM) fall within this category. ISFM includes a range of agricultural technologies to improve the use of nutrients and water and to increase crop yields. These practices include the combined use of mineral fertilizers, soil amendments (such as lime and rock phosphate) and organic matter (crop residues, compost and green manure); agroforestry (the combination of crops and trees including Nitrogen fixing fertilizer trees, crop rotation and intercropping with legumes and conservation agriculture (no-till farming that uses a combination of mulch, direct planting and crop rotation to maintain fertility, prevent erosion and suppress weeds) (cited from AGRA and IIRC 2014). Thus, by improving the health of the soil, i.e., its ability to store and gradually release nutrients and water, ISFM, both directly and indirectly improves yields through increasing effectiveness of other inputs (Marenya and Barrett 2007).

The adoption of these technologies could change the future of its soils. We know that soil fertility is low and declining in Sub-Saharan Africa (see, among others, Tully et al. 2015 and Njoloma et al. 2016, Sanchez 2002). Hence, the benefits of ISFM in terms of increasing average yields and reducing yield variance can be substantial (see, among others, Kerr et al. 2007, Duflo et al. 2008, Sauer and Tchale 2009, Fairhurst 2012, Bezu et al. 2014, Franke et al. 2014 and Manda et al. 2016, Droppelman et al 2017), albeit heterogeneous, and conditional on farmer wealth and assets (see, among others, Marenya and Barrett 2007, Mugwe et al. 2009, Place et al. 2003, and for a critical review Vanlauwe and Giller 2006). However, overall, the adoption of ISFM technologies in Sub-Saharan Africa is still low (for a discussion, see, for instance, Wossen et al. 2015, Nkonya et al. 2016 and Nkonya et al. 2017, and Sheahan and Barrett 2017).

The Anchor Farm Model (AFM) of the Clinton Development Initiatives (CDI) works in rural Malawi with smallholder farmers. Established in 2008, the AFM is designed to increase agricultural production, income and food security through promotion of the adoption of yield-enhancing integrated soil fertility management practices (ISFM) - and soybean production in particular - by smallholder farmers in central Malawi. To reach this goal CDI disseminates production knowledge through the use of various extension mechanisms: demonstration plots, farmer clubs, lead farmers and farmer field days. These are very common mechanisms yet, as noted earlier, little is known about their relative effectiveness. Hence, our first project goal is to shed light on the relative effectiveness of these different extension mechanisms, and to gain a better understanding of the farmer's learning process.

In addition to extension interventions, CDI also aims to improve smallholder farmers' access to output markets and input credit, through CDI's contract with intermediaries. Indeed, the low agricultural productivity in Malawi and across Sub Saharan Africa cannot only be attributed to yield-related factors, such as the dependence on rain fed farming, or the low uptake of improved technologies. Output markets play a major role, and relatedly, high transport costs, inadequate farmer organizations, and missing or incomplete credit and input markets (Aggarwal et al. 2017, Burke et al. 2019, Stephens and Barrett 2011, Barrett 2008).

The Malawian government has recognised these market constraints, and in response, among others, in 2006, started a targeted farm input subsidy program. While this program has increased food production, primarily maize, the program has been criticized for its limited links to extension services and output markets (Chirwa and Dorward, 2013). It is these links that the AFM seeks to remedy. The AFM, with its extension and marketing component, uses a multipronged approach. While these multipronged agricultural programs have become more common in Africa (see, e.g. the Africa

Agriculture Status Report of AGRA of 2014, we have little evidence regarding how the various components interact with one another and which combinations prove to be cost-effective. For instance, in order to promote the adoption of ISFM techniques, is it sufficient to setup demonstration plots? Or should we also improve access to credit markets, quality inputs, and a less volatile output market? Our research study originally aimed to address this critical knowledge gap, and study the cost-effectiveness of both the extension components and the marketing components. However, as will become evident throughout the report, we did not entirely succeed in the latter goal, largely because the uptake of the marketing components of the program remained low throughout our study period. Nevertheless, we will shed light on the marketing constraints of smallholder farmers and the intersection between extension and markets.

When we started this research study, in 2014, CDI was operating in three districts in central Malawi: Mchinji, Dowa and Kasungu. Within Dowa and Kasungu there were several locations in which CDI had not worked till then. Each district is subdivided in many “sub-districts”, called Extension Planning Areas. Together with them, we, the research team, selected two Extension Planning Areas in which CDI was not working at that point in time – these were Chibvala EPA in Dowa district and Mthumthama EPA in Kasungu district. We randomly selected 250 villages, from all the villages (above a certain size cut-off) in these two EPAs, and randomly assigned 125 to an extension control group and 125 to an extension treatment group. The villages in the extension treatment group were requested to form farmer clubs, CDI’s preferred delivery method, and invited to participate in CDI’s extension program activities. While all (in the treatment group) were invited to farmer field-days, only a subset of clubs were selected to set up farmer demonstration plots. In the following years, CDI continued their program of extension within these 125 villages to varying degrees. In the final year of our study project, in 2017, CDI rolled out their marketing treatment. Again, we created an equal-sized marketing control group and a marketing treatment group, orthogonal to the other two treatment groups. Only farmers in the marketing treatment group were invited to a meeting introducing farmers to a new output market, featuring higher prices.

Using detailed panel data collected among 2500 farming households, we identified the effects of these programs on farmer’s knowledge of ISFM, adoption of ISFM, yield, prices and revenues. We also shed light on the channels through which impacts take place and explore heterogeneity across household composition and soil characteristics. While the original focus of our proposal was the interaction between the extension and the marketing component of the program, the limited uptake of the marketing program has limited us in terms of what we can credibly identify. However, in the course of our work in Malawi, we identified previously unanticipated areas of great importance, such as the diversity between the farmer clubs (which affects cooperation and effectiveness), the considerable soil heterogeneity (which affects the learning process) and the significant role of weather and market fluctuations both for the farmers, as for us, researchers, aiming to identify impacts.

Our research study ran from 2014 until 2019. In this report, we give an overview of the study. We cover sample design, context, descriptive statistics, methodology and results, and conclude with a discussion and implications. We expect that our lessons from this evaluation can provide tips for practitioners working in this area, and insights for policy-makers of agricultural development in other low-income countries like Malawi.

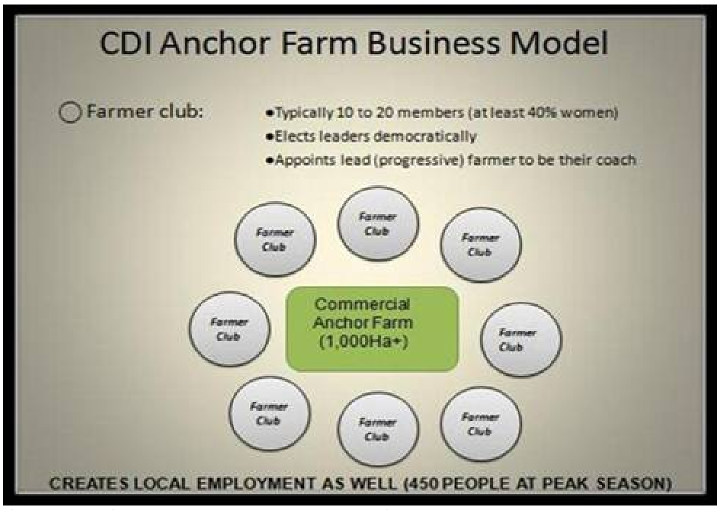
2. Intervention, theory of change and research hypotheses

2.1 The intervention

The Anchor Farm Model (AFM) of the Clinton Development Initiative (CDI) was established in 2008. AFM aims to increase agricultural production, income and food security through adoption of Integrated Soil Fertility Management practices (ISFM) - and soybean production in particular - by smallholder farmers in Malawi. To reach this goal: (i) CDI disseminates production knowledge through the use of demonstration plots, lead farmers and farmer field days, and (ii) CDI provides access to structured output markets. When we started the study, CDI had also planned to improve farmers' access to input markets, in particular credit and seed markets; but this component was never implemented in the study area beyond the pilot stage.

CDI primarily works with farmers in groups, organizing farmers into clubs of 10 to 20 members (see Figure 1). Each club selects a leader who is provided with inputs and training.

Figure 1: CDI's Anchor Farm Business Model



Source: CDI's Anchor Farm Leaflets

In Fall 2014, CDI planned to scale-up their program. At that time, CDI had sub-leased on a long term basis four AF sites, two in Kasungu (at Santhe) and two in Mchinji (at Mphelero and Mkanda). As we'll expand on in a next section, we worked with CDI to identify 2500 farming households in 250 villages within the following Extension Planning Areas (EPAs) (these are essentially sub-districts) covered by the CDI's planned project scale-up at the time: Mthumthama in Kasungu district and Chibvala in Dowa district. In this research project, we aimed to support CDI in their scale-up by evaluating the impacts of CDI's extension and marketing activities.

2.2 Theory of change

Smallholder farmer production and food security in SSA has received renewed attention through "smart subsidy" programs, such as the Malawi Input Subsidy Program. However, in order to sustain the early achievements of these programs two challenges must be addressed. First, the volatile and increasing costs of synthesized inorganic fertilizers, tied to the volatile price of energy, may jeopardize the future of the subsidies. Second, mineral fertilizers alone are unlikely to provide critical micronutrients such as zinc and manganese and will not in most cases sufficiently rebuild carbon stocks, critical to soil water holding capacity and structure.

For the last several decades, researchers and NGOs have promoted integrated soil fertility management (ISFM) as a low-cost option for smallholder farmers to improve soil conditions and increase yields. ISFM technologies promoted in Malawi include: combined use of organic and inorganic fertilizers, legume crops as intercrops or in rotation, agroforestry and inoculation of soybean. Organic fertilizers, such as manure and crop residues, improve the chemical, physical and biological properties of soils, important for sustaining crop yields (Chivenge et. al, 2011). Legumes improve soil nitrogen by fixing atmospheric nitrogen and complement inorganic fertilizers in cereal-based systems (Giller, 2001). Inoculation with rhizobia improves the soybean plant's ability to nodulate. Experiments at research stations in Malawi identified strong positive effects of ISFM on maize yields, up to 100% in the case of maize over a period of four years (Akinnifesi et al., 2007; Mafongoya et al., 2006). Importantly, the costs of these organic sources of nitrogen and carbon are largely independent of the international price of energy.

Yet despite the potential benefits and its widespread promotion, ISFM adoption remains low. Kanyama-Phiri et al. (2000) note an adoption rate of 10% in Kasungu district in Malawi. While some of this low uptake might be due to heterogeneity in soil and climatic conditions, other explanations include delayed benefits, incomplete labour markets (labour constraints), insufficient access to credit or quality inputs, limited landholding size, and lack of information (Snapp et al. 2002, Mafongoya et al. 2006, Mhango et al. 2012).

The Anchor Farm Model (AFM) addresses these constraints using a multipronged approach. The project uses demonstration plots as a primary tool for information dissemination about ISFM and soy. Indeed, as agricultural extension services in Sub-Saharan Africa are stretched thin – with one extension worker per 2000 farmers in Malawi – demonstration plots present themselves as a potential cost-effective alternative. In addition, AFM runs farmer field days. Our research provides insight into the following possible channels of impact of demonstration plots and farmer field days on farmers' incomes.

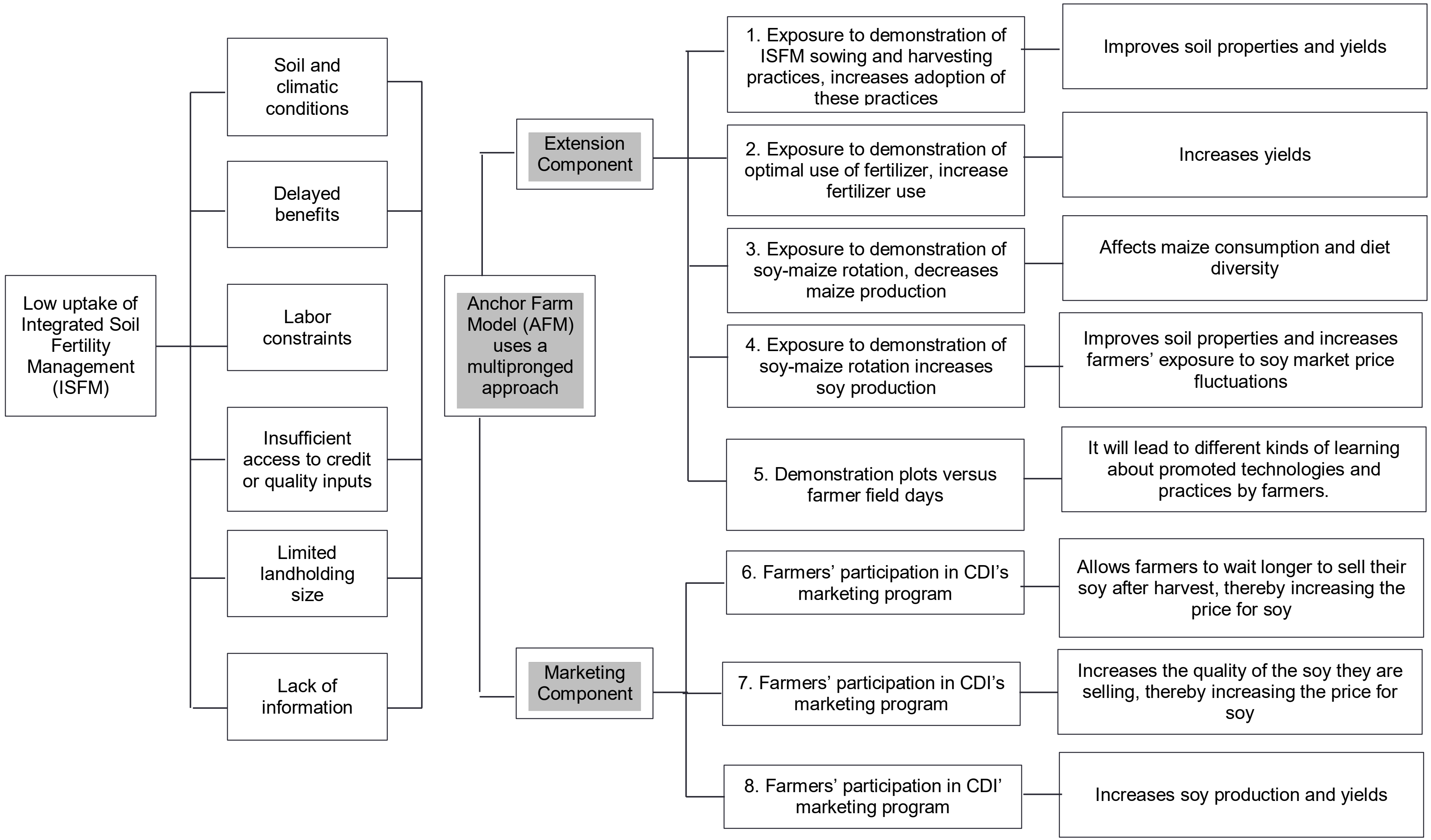
1. Exposure to demonstration of ISFM sowing and harvesting practices (sowing density, incorporation of residues, use of seed inoculant) *increases adoption of these practices, improves soil properties and yields*
2. Exposure to demonstration of optimal use of fertilizer *increases fertilizer use and increases yields*
3. Exposure to demonstration of soy-maize rotation *decreases total maize production and affects maize consumption and diet diversity*
4. Exposure to demonstration of soy-maize rotation *increases soy adoption, increases rotation thereby improving soil properties and increases farmers' exposure to soy market price fluctuations*
5. Participation in demonstration plots versus farmer field days will lead to different kinds of learning about promoted technologies and practices by farmers.

CDI implemented a marketing program that guaranteed (through a negotiated buyer) and announced a price for soy. This program was introduced in 2018. This led us to the following hypotheses:

6. Farmers' participation in CDI's marketing program *allows farmers to wait longer to sell their soy after harvest, thereby increasing the price they receive for soy*
7. Farmers' participation in CDI's marketing program *increases the quality of the soy they are selling (through use of improved storage facilities), thereby increasing the price they receive*.
8. Farmers' participation in the warehouse receipt system *increases soy adoption and yields as they respond to the market incentives*

Figure 2 presents the theory of change, with on the left the consequences of low uptake of ISFM and in the middle, the approaches of CDI. On the right-hand side, we present the expected consequences of CDI's approaches.

Figure 2: Theory of Change



Note that the first five points of the theory of change relate to the extension component of the intervention, while the next three points relate to the marketing component of the intervention. Some of the effects on the intermediate (or secondary outcomes) can be expected to take place soon after the intervention, i.e., the following growing season. For instance, adoption of the various recommended ISFM technologies such as fertilizer. However, the effects of these adoption decisions on yields can only be measured the year after, and effects on other outcomes, such as consumption, diet diversity and assets can be expected to take longer to manifest. Similarly, the effects of the marketing program on prices can be expected to take place the same year as the program was implemented, but effects on market participation, and quality of produce can take longer. It is for this reason that we had set up the study as a five year study. The five year study follows the agricultural calendar, with the baseline being collected at the end of the 2013-2014 season and the endline being collected at the 2017-18 season. A midline, collected among a smaller sample, can capture some immediate responses to the extension component after the 2014-15 season.

2.3 Research hypotheses

We hypothesise that the AFM interventions, through this theory of change, affect the farmers' knowledge of ISFM technologies, adoption of ISFM practices, yields, prices and times of sales, and incomes. We consider:

- (R1) field days
- (R2) demonstration plots
- (R3) output marketing assistance

In addition, we considered:

- (A1) Heterogeneity of effects (labour/credit constraints, gender, soil properties)
- (A2) Short versus long term effects
- (A3) functioning of farmer groups

Our original project proposal placed much emphasis on the interaction between the treatments, however, as we will return to later, the uptake of treatment (R3) was limited, which limits us in terms of our analysis. In addition, we do not cover the social network effects much in this report, largely due to its complexity and need for further research. We refer to Nourani et al. (2019) for more details on the clubs and their networks.

Complementing the quantitative and agronomic data with qualitative data we had hoped to address: How can qualitative methods assist in understanding group dynamics of club-managed demonstration plots? This research question was considerably expanded upon throughout the study, as we came to the realisation that cultural and social norms were key to understanding the functioning of the farmer clubs, the village interactions, and the spill-overs between farmers.

2.4 A few notes on changes from the original proposal

A few changes occurred to the original design by the implementer that led to adjustments in our evaluation design and hypotheses.

First, we originally proposed individual demonstration plots but we ended up with a relatively small number (19 in 17 villages) of demonstration plots managed by farmer groups. In our original proposal, we had proposed an individual-managed demonstration plot but this appeared very difficult to implement from a logistical perspective: the manager of the plot would still need inputs and labour; and the latter would have to be hired on the casual labour market, possibly even increasing moral hazard (not to mention that the issue of who would pay for this labour could not be resolved in a straightforward manner). In addition, we found during the qualitative interviews that all clubs do the labour on the field together, given very little opportunity for each individual to slack off, as everyone can observe everyone else. It seemed that getting the tasks done was more a matter of organization and leadership rather than slacking off once you are on the field. Hence, we decided to drop this sub-treatment and add questions on coordination and leadership instead. Hence, in the revised proposal, all the club members are expected to contribute labour to the cultivation of the demonstration. As compensation for their labour, farmer club members receive a share of the output.

Second, the original research proposal mentioned that 72 villages would receive demonstration plots. These would be randomly selected. However, CDI did not have the funds to cover that many, and most years we had fewer than 20 demonstration plots. These plots were not randomly selected, a situation to which we had to adapt in terms of empirical strategy. This also affected our ability to create ISFM response functions, as the number of the demonstration plots within each type were too few to do meaningful statistical agronomic analysis.

Third, the original proposal also mentioned the possibility of the use of SMS messages for extension. While SMS messages were used, they were part of the marketing treatment, not the extension treatment.

Fourth, the original proposal also had CDI implementing a warehouse receipt system -- a form of providing credit to farmers for inventory held in storage. CDI had planned to mobilize farmers to deposit soy in AF warehouses after harvest. While CDI identifies buyers, farmers could use the warehouse receipt to borrow funds from a partner bank using their stored product as collateral, up to 70% of the expected revenues. Hence, the warehouse receipt program can be a mechanism to alleviate credit constraints at the time of harvest, allowing farmers to postpone selling their production until a better price is offered. By providing improved storage, a warehouse receipt system can also increase product quality and contribute to lower post-harvest losses. The system can also lower transaction costs for buyers and sellers by providing quality assurances and product aggregation. However, while CDI implemented a market intervention, and some aggregation in warehouses took place, this did not include the credit component of the warehouse receipt system. It should also be noted that the implementation of this program was delayed by two years compared to what we had initially planned.

Our original research hypotheses and empirical strategies were revised to respond to the changes made by CDI as the implementation changed. In this report, we account the actual project, and not the project that we had planned for in 2014.

3. Context

The study was conducted in the Lilongwe-Kasungu Plain Livelihood Zone, where maize is a dominant crop among smallholder farmers, where maize is primarily cultivated as a source of own food with a small proportion going through the market and exchange systems. The Lilongwe-Kasungu Plain is the largest of the seventeen agricultural livelihood zones accounting for 27.1% of the population (MVAC 2005). According to MVAC (2005), the Lilongwe-Kasungu Plain is described as a relatively productive area with undiversified maize and tobacco cultivation and limited cultivation of other crops such as groundnuts, sweet potatoes and soya beans. Tobacco has been the single most important cash crop for smallholder farmers in this area since liberalisation of tobacco cultivation in 1992. With the poor performance of the tobacco sector and unstable tobacco prices, smallholder farmers have over time been diversifying into other cash crops particularly into soya bean production as a substitute for tobacco. Administratively, this area covers most of the central region in Malawi covering the following districts: Mchinji, Lilongwe, Kasungu, Dowa, Ntchisi, and partly Mzimba and Dedza.

The choice of the study area was determined by the operational area of CDI in the implementation of their Anchor Farm model, a model that is the subject of the study for integrated soil fertility management practices. The first anchor farm under CDI is located in Mchinji district, and their second farm was in Kasungu with the operational areas covering two adjacent districts of Kasungu and Dowa. Kasungu and Dowa, both fall in the Kasungu Agricultural Development Division (ADD). Each ADD is divided into Extension Planning Areas (EPAs) which are in turn sub-divided into sections as the smallest unit for agricultural extension services. The study was conducted in two EPAs, one in Kasungu district and one in Dowa district. The total population in Kasungu and Dowa in 2008 was 623,592 and 559,849, growing by 2.9% and 3.1% annually by 2018, respectively (NSO, 2018). The population of these two districts accounted for 9.2% of the national population in 2018. Migration rates in Kasungu and Dowa were estimated at 10.6% and 7.8% in 2016/17, respectively (NSO 2017).

The socio-economic characteristics in Kasungu and Dowa prior to the research in 2012 and more recently in 2017 are presented in Table 1. There are similarities in access to safe drinking water and access to improved sanitation, but access to safe drinking water slightly fell in Kasungu but increased in Dowa, and in both districts the proportion with access to improved sanitation declined. Literacy rates declined in Kasungu but increased slightly in Dowa district. There are also similarities in the proportion of the population reporting illness in both districts. The proportion operating non-farm enterprises declined in Kasungu from 26.6% in 2012 to 23.7% in 2017 in contrast to a large increase of 11.8% witnessed in Dowa over the same period. In terms of key agricultural statistics, there are minor differences with about 60% of plots with maize cultivation and 40-45% of plots with at least a legume crop. With respect to welfare measures, the food situation and poverty both worsened in the study districts between 2012 and 2017. The proportion of households that revealed inadequate consumption of food almost tripled in both districts and the poverty head count also increased, particularly in Kasungu from 33.6% to 53% between 2012 and 2017. Nationally, the poverty rate increased from 50.7% in 2011/12 to 51.5% in 2016/2017 (NSO and World Bank 2018). It should be noted that both districts were affected by droughts (Pauw et al. 2010) and political changes (Harrigan 2018).

These factors might have countered the positive impacts of the well-known agricultural subsidy program (Dorwa and Chirwa 2011).

As noted above the study sites are located within the largest livelihood zones in Malawi, a zone that was rated to be relatively productive and with the highest income levels compared to elsewhere in the country (MVAC, 2005). It does represent an area where both maize and a number of legumes are grown. Farming is mainly based on a single rain fed season, as is the case in most of the country. Similarly, these districts have credit constraints, similar to other parts of the livelihood zones. Agricultural markets for most of the crops are thin and unstructured following liberalization of markets in the late 1980s, with most smallholder farmers relying on spot markets provided by resident or mobile small-scale traders (venders). The constraints that impose the development of smallholder agriculture in the study sites are therefore similar in the rest of the economy including access to credit, access to profitable and reliable markets, poor road infrastructure and access to agricultural extension services.

Table 1: Selected Key Socio-economic Indicators for Kasungu and Dowa, 2012 – 2017

	Kasungu		**Dowa**	
Indicator	**2012**	**2017**	**2012**	**2017**
Proportion with access to safe drinking water (%)	68.0	66.7	64.0	70.5
Proportion with electricity in dwelling (%)	2.1	1.8	5.1	2.8
Proportion with access to improved sanitation (%)	74.1	73.3	76.4	72.1
Proportion owning a radio (%)	49.8	31.6	45.5	39.0
Literacy rate (%)	78.8	72.2	70.3	73.3
Proportion reporting Illness (%)	22.6	30.5	20.4	32.9
Labour force participation rate (%)	96.8	-	94.5	-
Proportion in wage employment (%)	11.3	-	41.5	-
Proportion operating non-farm enterprise (%)	26.6	23.7	15.1	26.9
Proportion accessing credit (%)	14.4	12.8	12.4	17.8
Average cultivated areas (acres)	-	2.7	-	2.3
Proportion of plots with maize (%)	-	59.6	-	62.3
Proportion of plots with tobacco (%)	-	14.1	-	12.2
Proportion of plots with legumes (%)	-	45.9	-	40.1
Proportion with inadequate food consumption (%)	25.4	73.0	28.5	65.7
Poverty head count (%)	33.6	53.0	45.6	48.8

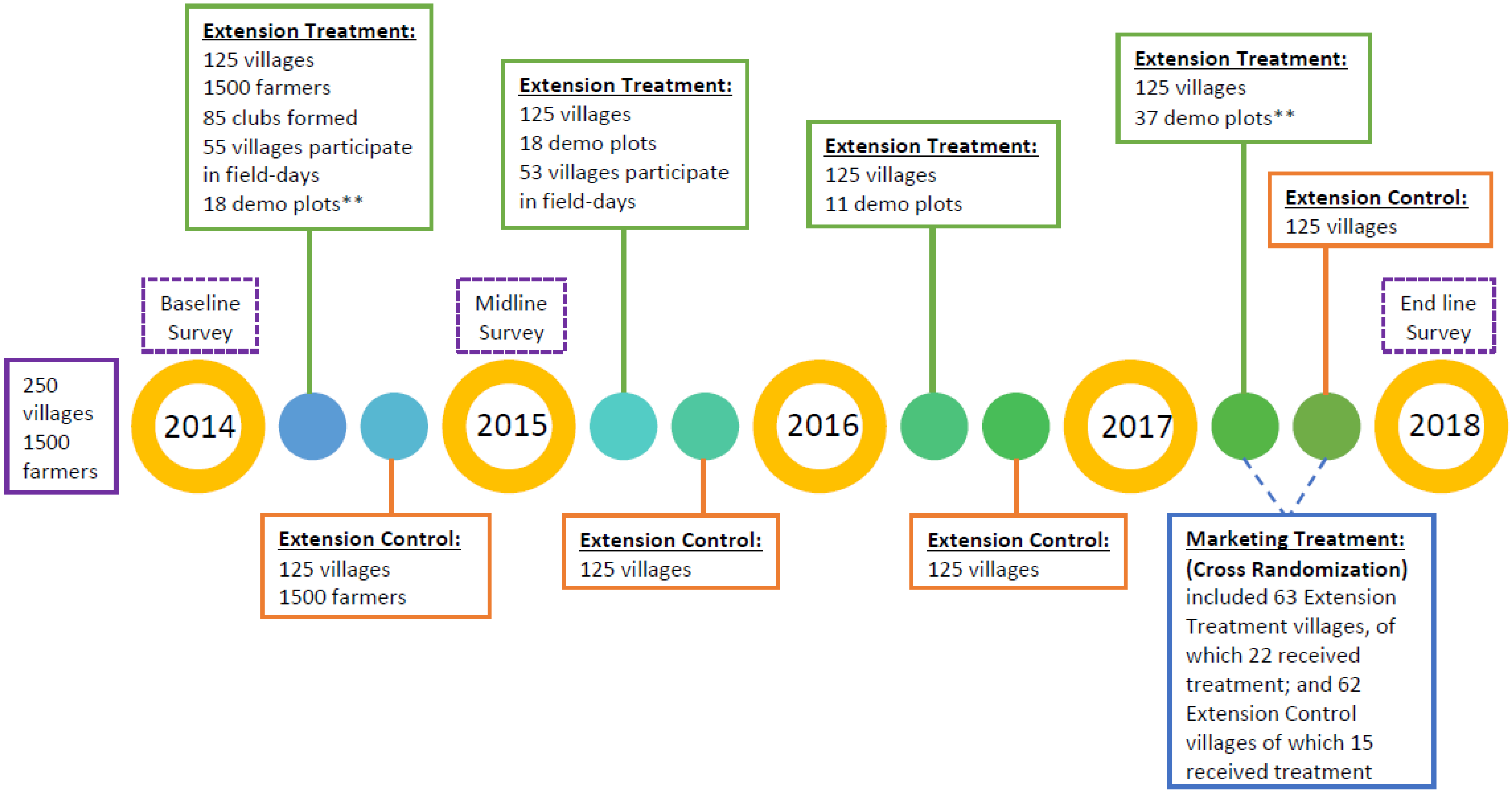
Source: NSO (2012 and 2017) and NSO and World Bank (2018)

4. Timeline

We begin by describing the timeline for CDI's interventions. Figure 3 presents a visualization. Before we proceed, a note on the agronomic calendar. In Malawi, there is a rainy season (running from November/December till April/May) and a dry season (running from May/June till October/November). The main agricultural season is the rainy season, as most crops are rain fed. Both CDI's timeline and our timeline revolved around this agricultural calendar, with farmer interviews conducted after harvest (but before planting for the next season starts) and CDI's programs running throughout the rainy season.

CDI implemented demonstration plots and field days in 125 treatment villages; these programs happened in two consecutive years, 2014-2015 and 2015-2016. In 2016-17, CDI continued only with the demonstration plots, and not the field days. In 2017-18, the last year of the project, CDI expanded its extension intervention, from around 20 villages in the previous years, to 60 villages.

Figure 3: Timeline of the data collection and implementation



** Some demonstration plots were mounted in extension control villages, from 1 in 2014 to 5 in 2018. To keep the overview simple, we noted the total number only.

The marketing program was implemented in 2017-18 at scale. CDI tried to start of the program earlier, in 2015-16 when CDI tried to roll out the marketing program as planned, but bumped into logistical constraints, postponing the introduction to the following year. In 2016-17, CDI did introduce the program, but only on very limited scale.

Our activities related to data collection and assessment occurred throughout CDI's implementation. We collected household and village data in baseline in 2014, midline in 2015, and endline in 2018.

In addition to these three main rounds of data collection, we also collected monitoring data on an ongoing basis, and collected data on the demonstration plots. We visited the demonstration plots two weeks after planting to record germination and record activities and inputs used to up to that date. Data on agronomic practices were recorded via a phone call with the lead farmer on a weekly basis between planting and harvesting. During this weekly phone call we recorded any activity that had taken place, such as applying fertilizer or other inputs, and the number of club members and other visitors present for the activity (including whether the CDI extension agent was present). Rainfall gauges were mounted on each demonstration plot and the lead farmer was trained to record rainfall on a daily basis. At harvest, we visited the demonstration plots and collected crop yield data. We recorded the stand count at harvest, the total biomass, grain yield and stover or leafy biomass. Grain moisture content was determined using a Mini GAC plus moisture meter. It is important to note that the club members were present during these on-field activities, and hence, are expected to have good idea of the planting and harvesting counts.

We also collected soil data at base, mid, and endline among demonstration plots and selected farmer plots. The key indicators of land fertility in the study area are soil pH and organic matter content (see Snapp 1998). We collected soil samples from a total of 225 farmers' fields in addition to the 19 demonstration plots during November-December 2014 and 2015. For each field, we first recorded the cropping history and then asked the farmer to guide us to the field. After recording the GPS coordinates of the field in a central location and walking around the field to record the field area, we collected two soil samples at 0-20 cm soil depth. These samples were then mixed to make a composite sample. After collection, the soil samples are put in soil sampling bags and taken to the Bunda College Soil and Plant Analysis Laboratory for analysis. If the soils were wet upon arrival at the laboratory, the samples were first air dried. When dry, we sieved them through a 2mm sieve and recorded the soil texture using the hand feel method.

Finally, we collected qualitative data on a regular basis. The qualitative component of the research was an integral part of the study and provided background to our research study, informed the data instruments, explained puzzling findings and sometimes threw up new research hypotheses. We conducted semi-structured interviews with farmers and extension agents, and farmer focus group interviews. We did at least one qualitative round each year, but some years did up to four. We followed Morgan (1996) and Krueger and Casey (2008) in our design of the focus groups.

5. Evaluation: design, methods and implementation

Our project followed a mixed methods approach. We relied on the following data sources: (i) Qualitative data, (ii) Household data, (iii) Village data, (iv) Monitoring data, (v) Agronomic data, (vi) Secondary data. Table 2 gives an overview of the data.

Table 2: Overview of data sources

	Baseline	Midline	Endline
Agronomic data	Soil sampling, GPS tagging of demonstration plots. Rainfall near demonstration plots Yields on demonstration plots, Activities on demonstration plots	Rainfall near demonstration plots Yields on demonstration plots, Activities on demonstration plots	Soil sampling, Rainfall near demonstration plots Yields on demonstration plots, Activities on demonstration plots
Household data	Household composition and identification Landholding Assets Marketing and agricultural input/output for 2013-14 Time preferences Beliefs regarding ISFM Social networks Recall on ISFM adoption	Changes in household composition and identification Social networks Participation in CDI activities Beliefs regarding ISFM Adoption plans and constraints to adoption Credit and insurance constraints Knowledge about ISFM techniques Marketing and agricultural input/output for 2014-15	Changes in household composition and identification Social networks Participation in CDI activities Beliefs regarding ISFM and prices Adoption plans and constraints to adoption Credit and insurance constraints Knowledge about ISFM techniques Marketing and agricultural input/output for 2017-18 Dietary diversity Assets
Qualitative data	Focus group surveys Semi-structured qualitative interviews among stakeholders	Focus group surveys Semi-structured qualitative interviews among stakeholders	Focus group surveys Semi-structured qualitative interviews among stakeholders

	Baseline	Midline	Endline
Village data	GPS-tagged locations, attributes villages, social norms measured through lab-in-the-field games	Social norms measured through lab-in-the-field games	GPS-tagged locations, attributes villages, social norms measured through lab-in-the-field games
Monitoring data	Participation in field-day, demonstration plots and marketing activities	Participation in field-day, demonstration plots and marketing activities	Participation in field-day, demonstration plots and marketing activities
Secondary sources	Rainfall	Rainfall	Rainfall Market prices

5.1 Research ethics

We followed procedures outlined by the (main) universities involved (Illinois, Pittsburgh, Sussex, the University of Malawi and Bunda College) regarding human subjects, and the government of Malawi. Specifically, we informed the participants of purpose of the study, introduced the research team and disclosed the source of funding. We then proceeded with requesting written or oral permission to start the interview. We emphasized that they are free to withdraw from the research study at any point in time during the interview or the years. No individual was excluded from the intervention because they refused to participate in the research study. All data remained confidential and the entire survey team was trained in ethical data collection. The results of our study will be shared with participants in a variety of ways. Finally, we provided input to CDI to expand their program to control areas when our evaluation was completed, in particular of the demonstration plot component which was most successful.

5.2 Sample size determination

Prior to starting the study, we conducted a power calculation to settle on the size of the sample needed. Power measures the probability that we avoid Type II errors, or failure to reject the null hypothesis when it is in fact false (false negative). We conducted the power analysis using an 80% power using data from Malawi's 2008 Third Integrated Household Survey. We follow Glennerster and Takavarasha (2013) to compute the required sample size and/or Minimum Detectable Effect Size (MDE) using Stata's *sampsi* and *sampclus* commands, allowing for clustering within the villages. Based on Gilbert et al. (20011), we assume an attrition rate of 21% over 5 years; or a treatment group size of 400 farmers by the endline if we were to start with 500 farmers at baseline – this appeared to be quite generous, the actual attrition rate was 12%. Using data from the Integrated Household Survey, we computed country-level statistics of mean and variances of the relevant variables (and used within versus between district variation to compute a 'rho').

Table 3 reports the results of our computations. Details are included in Online Appendix B. These MDEs are the differences we can pick up comparing any of the treatment groups with the control or any of the treatment groups with each other. For instance, we can pick up a 34% difference in fertilizer use (kg/ha) between the demonstration plot treatment and the warehouse receipt treatment. While the MDEs appeared quite large, especially of expenditures, we argued, on the basis of prior literature, that the sample size would be sufficient to pick up effects on secondary (intermediate) outcomes. While a smaller MDE would have been better, the budget constraints implied limits in terms of the expansion of the sample. In addition we noted at the time (in 2014) that compared to district-level analysis, our method had overestimated the variance, underestimated rho, and possibly overestimated the MDE. We hence re-estimated the MDE after the baseline data was collected in 2015 and confirmed these suspicions (See the baseline report of the project for details, available from the authors in request).

Table 3: MDE of household level outcome variables

Outcome variable	***Results***	***Assumptions***		
	MDE	***Mean***	***St. Dev.***	***Rho***
Yield soy (ton/ha)	38%	0.54	0.68	0.16
Yield maize (ton/ha)	31%	0.80	0.88	0.12
Adoption soy (ha)	43%	0.33	0.43	0.15
Household per capita yearly expenditure (MK)	60%	3130	5781	0.2
Fertilizer use (kg/ha)	34%	39	41	0.2

Notes: We assumed a group size of N=400 (this assumes an attrition of 20% between base and endline); 10 farmers per village cluster. (5) is based on a 2000 IFPRI study by Minot et al. (2000) – Rho is assumed to be 0.2; (4) is based on Makoka (2009), rural Malawi only – Rho is assumed to be 0.2. Based on these computations, reported in the project proposal, we settled on a sample size of 250 villages in total. At the time of the project proposal, we had five treatment groups. However, due to changes in the design, as reported in the previous section, we ended up with only two main treatments, and a combined (interaction) treatment.

5.3 Sampling design

In Fall 2014, CDI had planned to further scale-up the implementation of its project to cover an additional 30,000 farmers in the central districts of Kasungu and Dowa. In Malawi, for the purpose of agricultural extension, districts are further divided up into Extension Planning Areas. It is these EPAs which we considered as the relevant sub-district units. Out of the seven EPAs which had not yet been covered by CDI by January 2014, we, together with CDI, selected two for the purpose of our study: Mthumthama in Kasungu district and Chibvala in Dowa district. Note that the Anchor Farms (AFs) did not border any of these EPAs. Note however that these selected EPAs are comparable to the other EPAs in the district (see Table 4)

Table 4: EPAs covered by the CDI project, descriptive statistics

	Dowa and Kasungu EPAs	
	New CDI project EPASs	**Existing Project EPAs**
Total households in EPA (EPA mean)	22,299	28,347
Female headed households (share)	22.45	23.59
Dependency ratio (dependents per working-age household member)	0.95	0.95
Population density (per sq km)	107.49	108.94
Poverty headcount	57.57	50.18
Ultra poverty headcount	29.92	22.92

Source: Malawi Government and World Bank, 2007

Once we had selected the EPAs, we randomly selected 250 villages from the existing 303 villages, which counted at least 50 households, stratified by EPA. Within each village, we selected 10 farming households, again randomly. Initially, we had planned to use the official government lists of farming households of the District Agricultural Office. We however quickly realized that these list were inaccurate and conducted our own village census prior to the data collection. In the villages with a farmer's club, this sample was stratified by club membership (with 5 club members and 5 non club members).

5.4 Randomization

The research team conducted the randomization using Stata. The randomization was not public, and the participants of the study were not aware of this randomization. Naturally, the CDI team were aware and onboard with the strategy. From the original 250 baseline villages, we selected half randomly, stratified by EPA, and assigned them to the extension treatment group. The other half were assigned to the extension control group. The villages in the extension treatment group (125) were invited to form farmer clubs and to participate in CDI's program. Seventeen of the 125 treatment villages were selected by CDI to receive farmer-led demonstration plots during the 2014-15 growing season, while the others were only invited to attend farmer field days. In the following three years, the extension treatment continued following a similar structure. By CDI's own account, the villages selected for demonstration plots were villages with some familiarity with agricultural extension services, located in an accessible location and where people were in "unity". Table 26 at the end of this report compares the demonstration plot villages with the other treatment villages in the midline study sample, and reports few significant observable differences between these two sets. We will return to this matter of non-random selection. In 2017-18, we again randomly selected half of the villages, this time stratified both by EPA and extension treatment status, to participate in the marketing treatment. The 125 villages on this marketing treatment list were eligible to participate in the marketing program.

5.5 Data collection process and data quality control

Household and village data was collected by research assistants trained by Co-Principal Investigators in Malawi. The research assistants included graduate students and school leavers with post-secondary certificates. The research assistants worked across treatment and comparison arms of the research, with some of the research assistants participating in all three rounds of data collection. No compensation was provided to respondents for participation in the research, all participation was voluntary. The main quality control measure for data collection was spot supervision by the field team supervisor and back checks on some of the key questions, in addition to periodic checks by the Co-Principal Investigators during supervision missions during data collection.

Data entry was conducted using a system of double entry, where two data clerks entered the same batch of questionnaires independently. The two sets of entries were compared to determine differences, which were resolved through hard copy checks. There was also regular supervision of data entry by the Co-PIs. In addition, after all data were compiled, a final check on consistencies and extreme values was conducted through Stata data cleaning codes and follow-up with respondents through phone calls were made where it was necessary.

Agronomic data was collected by students at Bunda College, trained by Co-Investigators in Malawi, using standardised protocols. We have made these protocols available on the project website http://www.isfmmalawi.com/. Qualitative data was collected by the researchers themselves and monitoring data was collected on the spot, at the events, by the program manager.

A note on the timing of the data collected. Figure 3 presented the timeline of the intervention and data collection. One will note that we collected data among farmers in September-October. This is about a few months after the harvest, and usually the time when most sales are completed. The choice of this timeline was driven by the concern to be able to both capture these sales, but not introduce a significant recall bias. See Beegle et al. (2012) for a detailed discussion on recall bias in agricultural data, and Bardasi et al. (2011) for a more general discussion.

Independent of the timing of the data collected, measurement error in acreage and amount harvested might be substantial, especially when fields are intercropped. Both could affect measurement of yield expectations which we elicited at base, mid and endline.[1] We noted that the quality of the acreage, yield and yield expectation data was higher among demonstration plot participants compared to farmers invited to attend field-days. While some degree of sample selection might be at play, it is also possible that the surveys themselves have influenced this. For instance, demonstration plot participants measured their plot and yields as part of their activities. We hence do not include any results which use these variables as outcome variables and refer to Maertens et al. (2019) for additional results and discussions.

[1] In the baseline data, while mono-cropping was the norm (with 75% of the plots mono-cropped), inter-cropping is common. Due to the complexity in generating per-acre beliefs on inter-cropped fields, we asked the respondent to imagine a mono-cropped field. The unit was determined in qualitative interviews preceding the data collection as most common unit people think about for the crop. In addition, we recognise the difficulty in imagining the exact size of one acre of land, and in the formulation of this question we often referred to a 70 by 70 feet area or provided a comparison field in the village. However, we do expect measurement error due to the lack of ability to imagine exactly the size of one acre, and also asked the respondent for the expected yields on a particular field, instead of a per-acre basis (see also Bevis and Barrett 2019).

6. Programme or policy: Design, methods and implementation

In this section, we describe the CDI program components in more detail.

6.1 Club formation

All villages in the extension treatment were invited to a sensitisation meeting in 2015. During this meeting farmers were informed about the AFM. At the end of the meeting, farmers were asked to form groups between 10 and 20 farmers. One to two weeks later, the local government extension agent contacted the village chiefs and asked them to list the group members. Once the groups were formed, a leader, called a lead farmer, is selected by the club members and this leader's contact information was passed on by the village chief to the CDI extension agent.

6.2 Farmer field days

All club farmers in the extension treatment villages were invited to farmer field days in the first two years of the program. A total of two farmer field days were held per year, at the best performing demonstration plots in April/May. Each field day lasted one day and was led by the CDI extension agent, supported by the farmers of the relevant farmer club. As the field day was held at the end of the growing season, the farmers could see the mature crop on the fields. Throughout the day, the extension agent and lead club farmers, spoke about and illustrated the various ISFM techniques used.

6.3 Demonstration plots

Demonstration plots are a defined area within the village where a new concept is shown to farmers, often located for comparison next to a plot demonstrating farmers' standard agricultural practices. Each demonstration plot featured three similar agronomic treatments each year – except for the final year – when only the best practice sub-plots were cultivated. All treatments featured the following ISFM recommended practices: optimal planting date and density and incorporation of crop residues post-harvest. Table 5 has an example design.

Table 5: Example demonstration plot design

Plot	Year One	Year Two
1	Soybean + inoculation with Rhizobium	Maize + fertilizer (half and full rate)
2	Soybean, no inoculation	Maize + fertilizer (half and full rate)
3	Maize	Maize, unfertilized, half and full rate

These types of standard demonstration plots were implemented from 2014/15 to 2016/17 seasons. There were three types of demonstration plots: soybean-maize, groundnut-maize and bean-maize. The treatments included a control, farmer practice and best practice agronomy package as described by CDI. Some of the practices under best practice agronomy were inoculation of soybean recommended agronomic practices recommendation.

Table 6: Number of demonstration plots, by district

Cropping Season	Type of Demo	Number of demonstration plots		
		Chibvala	Mthumthama	Total
2014/2015	Soybean-maize	5	7	12
	Groundnut-maize	1	2	2
	Beans-maize	2	2	4
2015/2016	Soybean-maize	5	8	13
	Groundnut-maize	1	1	2
	Beans-maize	2	2	4
2016/2017	Soybean-maize	2	4	6
	Groundnut-maize	2	1	3
	Beans-maize	2	1	3

In 2017-2018 season, there was a change from demonstrations plots to demonstration gardens whereby only soybean was grown on a large area (at least 2 acres). Two hub farmers were selected in each EPA to guide the 37 selected farmer clubs on these demonstration gardens. Note that the hub farmers are different from the lead farmers. A hub farmer leads several clubs, and in a way plays the role of an extension agent, while a lead farmer guides just one club. All the club members were expected to contribute labour to the cultivation of the demonstration plot. As compensation for their labour, farmers' club members received a share of the demonstration plot output.

6.4 Output marketing program

The output marketing program started with a sensitisation meeting immediately after harvest. All villages on the marketing treatment list were invited. The CDI hub farmer led the meeting, sometimes under the supervision of the CDI extension agent. The purpose of the meeting was to provide information to farmers regarding CDI`s output marketing arrangements. Farmers were advised to properly clean and grade their produce. After the meeting was done, phone numbers were collected of the village chiefs or lead farmers. The hub farmer shared information on the market price of the main crops at local markets via SMS on a weekly basis throughout the sales season. In addition, the hub farmers informed the farmer clubs about the price offered by CDI's arranged buyer, also on a regular basis.

6.5 Monitoring data

We collected monitoring data at every juncture. We had attendance lists for every sensitization meeting in 2014 (for the extension treatment) and in 2018 (for the marketing treatment), allowing us to count the participants from each village. We also attended these meetings and noted down the content of what was said, and farmer's reactions. Lead farmers were trained at the end of 2014. We attended this training, and recorded the participants' names. We also had attendance lists for the farmer field days which took place in 2015 and 2016 for the same purpose. There, we also noted down program content, and recorded farmers' reactions.

We followed the demonstration plot activities in detail, as noted under section (4). We collected soil data, planting data, acreage information, yield data and rainfall data using standard protocols. In addition, in the first two years, we also called up the club leader every week to ask him/her about activities on the demonstration plot and the number of participants from various groups.

We also followed up on the marketing treatment in 2017-18, including the attempts in the earlier years. We attended the marketing sensitization meetings, and were in touch with the hub farmers as they shared the market prices with the lead farmers of the clubs to check on content and frequency of the messages. However, we were unable to be present during the sales of the crop to the CDI arranged buyer. This was due to the fact that the sales could happen at any time of the season, and as the sales location about a 6 hours' drive from Bunda College, it was not feasible for us to have this type of continuous presence. However, we did contact all farmer clubs which the CDI arranged buyer noted had sold produce.

7. Impact analysis and results of the key evaluation questions

This section provides an overview of the key results of the project. Section 7.1 reviews some of the key baseline descriptive statistics. Section 7.2 recaps the hypotheses and presents the empirical specifications. Section 7.3 presents the main results, both quantitative and qualitative. Section 7.4 presents results relating to heterogeneities of impact and Section 7.5 presents information on the cost of CDI's program components.

7.1 Baseline descriptive statistics

In this sub-section, we highlight some baseline descriptive statistics, aiming to set the stage for the analysis and results. The full set of baseline descriptive statistics are available in Online Appendix G.

Recall that one of the main goals of Integrated Soil Fertility Management (ISFM) practices is to improve the fertility of soils, thereby increasing agricultural yields and incomes. As such, it is useful to look at what the soil fertility looks like at baseline. Table 7 provides an overview of the soil fertility, as perceived by the respondent at the time of the baseline survey (in 2014).

Table 7: Perceived soil fertility status at baseline

Question	Question options	Percentage of fields
What is the soil fertility of this field? (yes)	Very poor	6
	Somewhat poor	17
	Average	25
	Somewhat Good	31
	Very Good	21
In the last five years, has the soil fertility of this field (yes)	Improved a lot	6
	improved a little	12
	stayed the same	40
	became worse a little	37
	became worse a lot	4
Does this field suffer from soil degradation in the form of (multiple)	Soil erosion	43
	Nutrient depletion	53
	Water logging	22
	Salinity/acidity	5

Over 20% of fields are perceived to be of very poor to somewhat poor soil fertility. Soil fertility seems to have worsened over the years, as reported in the answer to the question: ‘In the last five years, has the soil fertility of this field improved/declined, etc.’: 80% of fields are perceived to have either stayed the same or worsened in terms of soil fertility. Independent of the soil type, most farmers experienced soil degradation in 2014, especially in the form of nutrient degradation but also soil erosion. Specifically, 43% of fields are reported to suffer from soil erosion, 53% suffers from nutrient depletion, and 22% suffers from water logging. A simple cross tabulation reveals that the quality of fields greatly varies by soil type. Clay fields, on average, have the best quality; with 60% being above average (These results are available on request).

These perceptions are consistent with the soil test results. Recall that we tested the soils of a subset of farmers and the demonstration plots. Tables 8 and 9 report the results of these tests in Chibvala and Mthumthama, respectively. 95%-96% of soils tested lack Nitrogen, a key element for plant growth, and almost half of the soils in Mthumthama lack carbon. We refer the reader to the agronomic reports of the project for more detail, also available on the project website.

Table 8: Results of soil tests at baseline in Chibvala

Variable	N	Mean	Std. Error	Range	Comment	%<critical value
pH in water	241	6.0	0.04	4.5-7.8	Slightly acid to neutral	2.3
Active carbon (mg kg^{-1})	240	503	9.79	91-918	Low to high	15.2
Nitrate N (mg kg^{-1})	230	6.6	0.534	0.0-97.7	Very low to medium	96.1
Potassium K (cmol kg^{-1})	241	0.85	0.041	0.0-3.18	low to high	-
Sulphur (mg kg^{-1})	241	8.66	0.177	2.82-19.15	Medium to high	1.5
Inorganic P (mg kg^{-1})	137	0.93	0.099	0.0-6.96	Low to high	15.6
Soil EC	241	0.54	.0242	0.11-3.71	Non saline to slightly saline	-

Notes: The critical Soil Doc soil test values used are: pH in H_2O=5.0; Active carbon: 350 mg C /kg Soil= moderate to poor; ≥ 350 – 700=moderate to good; >700=excellent; P= <0.1-0.3 mg kg^{-1} NO_3- : <21 mg/kg= very low; 21-42 mg/kg = low; 42-65 mg/kg – medium; Sulphur= <5 mg/kg; K=<10 mg/kg

Table 9: Results of soil tests at baseline in Mthumthama

Variable	N	Mean	Std. Error	Range	Comment	%<critical value
pH in water	293	6.2	0.026	4.4	Slightly acid to neutral	7.6
Active carbon (mg kg^{-1})	291	368	8.87	12-800	Very low to high	45.7
Nitrate N (mg kg^{-1})	282	6.76	0.37	0.00-44.09	Very low to medium	95.7
Potassium K (cmol kg^{-1})	293	0.79	0.034	.00-2.54	Low to high	-
Sulphur (mg kg^{-1})	292	9.64	0.24	3.63-23.3	Medium to high	1.0
Inorganic P (mg kg^{-1})	284	0.98	0.00	7.74-19.6	Low to high	17.6
Soil EC	293	0.39	0.012	0.06-.1.62	Non saline	-

Notes: The critical Soil Doc soil test values used are: pH in H_2O=5.0; Active carbon: 350 mg C /kg Soil= moderate to poor; ≥ 350 – 700=moderate to good; >700=excellent; P= <0.1-0.3 mg kg^{-1} NO_3- : <21 mg/kg= very low; 21-42 mg/kg = low; 42-65 mg/kg – medium; Sulphur= <5 mg/kg; K=<10 mg/kg

Despite these soil fertility issues, the adoption of ISFM practices at baseline was low. In 2014, we asked the respondent a series of recall questions (going back 5 years) on the use of ISFM technologies. Due to the recall period involved, we limited these questions to discrete yes/no type questions only. Table 10 reports the results. The majority of farmers report preparing the land by hand/hoe and using ridges to prepare the land for cultivation. A significant proportion of farmers complements the ridges with other features such as grass strips, drainage channels and water catchments with the goal of improving soil structure. Farmers report using a wide variety of techniques to improve soil fertility, ranging from incorporating crop residue at the time of planting to crop rotation. Most farmers report having planted soybean in the past (over 80%). The numbers are equally large for bean and groundnut, with over 90% reporting some cultivating experience on these two crops. Few farmers have experience with fertilizer trees and farmers do not actively use forms of pesticide and insecticide.

Table 10: Use of ISFM technologies in the past 5 years at baseline

Past Farming Activities (in %)

		Percentage of households
Have you used any of the following methods of land preparation in the past 5 years [% reports yes]	No tillage	4.5
	By Hands/hoe	99.6
	Ploughing with Animals	1.0
	Mechanized	0.2
	Other	0.2
Have you used any of the following soil conservation methods in the last 5 years [% reports yes]	Grass Strips	27.0
	Ridges	99.1
	Bench Terraces	1.2
	Drainage Channels	25.3
	Water Catchment	12.7
	Other	9.1
Have you used any of the following methods of soil Fertility Improvement in the past 5 years [% reports yes]	Crop Residue	66.7
	Animal Manure	63.4
	Inorganic Fertilizer	93.2
	Improved Fallow	18.0
	Legume Cover crop	3.5
	Compost	51.2
	Intercropping	34.8
	Crop Rotation	84.6
	Other	81.5
Have you planted any of the following legumes in the past 5 years [% reports yes]	Soybean	82.6
	Pigeon pea	12.8
	Groundnut	91.8
	Common bean	89.5
	Other	9.7
Have you planted any of the following soil fertility enhancing trees in the past 5 years [% reports yes]	Tephrosia	6.6
	Gliricidia	6.8
	Sesbania	2.8
	Other	12.1
Have you used any of the following pesticides/Herbicides in the past 5 years [% reports yes]	Insecticide	20.5
	Herbicide	1.2
	Fungicide	2.8
	Fumigant	2.1
	Other	0.1

Finally, let us present some statistics on marketing of crops. Recall that the CDI program consisted of two activities: Extension activities and Marketing activities. The latter aimed to increase market participation by increasing average price and reducing price volatility.

At baseline, 85% of households report participating in the agricultural output market in the 2013-14 season, i.e., these households have sold or plan to sell some of their output of the 2013-14 season. However, market participation greatly varies by crop. Table 11 gives an overview for the most important crops in the area: Soya beans, Maize, Groundnut, Beans and Tobacco.

Table 11: Market participation at baseline – by crop

	Market participation % of households who sold or plan to sell	Total amount sold/planning to sell as a percentage of total harvest
Tobacco	99.1	99
Soya bean	87.3	75
Groundnut	66.4	43.5
Beans	54.2	37.1
Maize	44	15.6

Note: This percentage is for all households who have harvested this particular crop

7.2 Hypotheses and empirical specifications

The overall goal of this project is to evaluate the effect of CDI's extension and marketing interventions on farmers' agronomic income. However, given the expected lack of power, we focussed testing the theory of change that relates to secondary outcomes: adoption of ISFM practices, yield and acreage of soy and maize, dietary diversity, beliefs about the costs/benefits of ISFM technologies, soil fertility, and prices and time of sales. Note that all of these variables, except for soil fertility, are self-reported.

We have three rounds of data: The baseline data, collected in 2014; the midline data, collected in 2015 and the endline data, collected in 2018. We investigate the following hypotheses as outlined in the theory of change section of the pre-analysis plan. The latter is included as Online Appendix D, and on the project website. We note any deviations from this plan, when applicable, below.

Regarding the extension component of CDI's program:

(1) Exposure to demonstration of ISFM sowing and harvesting practices (sowing density, incorporation of residues, use of seed inoculant) *increases adoption of these practices, improves soil properties and yields*

(2) Exposure to demonstration of optimal use of fertilizer *increases fertilizer use and increases yields*

(3) Exposure to demonstration of soy-maize rotation *decreases total maize production and affects maize consumption and diet diversity*

(4) Exposure to demonstration of soy-maize rotation *increases soy adoption, increases rotation thereby improving soil properties and increases farmers' exposure to soy market price fluctuations*

Regarding the marketing component of CDI’s program:

(5) Farmers’ participation in CDI’s marketing program *allows farmers to wait longer to sell their soy after harvest, thereby increasing the price they receive for soy*
(6) Farmers’ participation in CDI’s marketing program *increases the quality of the soy they are selling (through use of improved storage facilities), thereby increasing the price they receive*.
(7) Farmers’ participation in the warehouse receipt system *increases soy adoption and yields as they respond to the market incentives*

Note that we dropped the hypotheses related to the credit component of the program as well as related the SMS messages to demonstration plot clubs, as these components were never implemented. We used a mixed-method approach to investigate these hypotheses, including structured qualitative interviews with CDI personnel and farmers, focus groups with farmers, household surveys, and soil test.

Using the midline data, we test elements of hypotheses (1) through (4). Key in our estimation is the distinction between CDI club members and CDI non-club members. Recall that while we randomized access to CDI’s extension program in 2014-15 at a village level, only farmers who were CDI club members in the villages could participate. We hence expect a differential impact for CDI club members compared to non-club members.

Using the endline data, we test the remaining elements of hypotheses (1) through (4), and the hypotheses (5) through (7). Again, we randomized access to CDI’s marketing program at the village level. In this case, however, all village farmers could participate, and we do not necessarily expect a differential effect between club members and non-club members. We do not include effects on crop rotation and dietary diversity in this report. The latter was not measured at base and midline, due to budgetary constraints (while we had prepared a module on dietary diversity, this module took significant time during pre-testing due to the complexity and the fact that we had to wait for the person who prepares meals in the household). We expect to use the endline dietary diversity module in future research. Similarly, crop rotation cannot be measured with the reference to a single year, and hence, while data was collected, could not be included as one of the midline measures. As to maintain comparability across rounds, we omit crop rotation also from the endline analysis. Note that crop rotation was a well-established technique prior to our arrival, with around 85% of households adopting the technique. Hence, effects would necessarily be limited.

Before we proceed, we present evidence of the successful village-level randomization in Tables 12 and 13. We note that treatment and control villages in the 2014-15 extension treatment are not different at baseline (Table 12). Similarly, treatment and control villages in the 2017-18 marketing treatment are not different at baseline (Table 13).

Table 12: Differences between extension treatment and control villages at baseline

Variable	Mean (St. dev) Control	Mean (St. dev) Treatment	Difference in means (Treatment – Control)	P-value
Number of households	79 (89)	67 (61)	-13	0.17
Distance to a paved road (km)	2.66 (5.45)	2.23 (4.37)	-0.44	0.48
Distance to a national highway (km)	7.18 (9.09)	8.02 (10.93)	0.84	0.50
% Area under soy cultivation 2014	26.08 (20.94)	22.17 (14.88)	-3.90	0.09
% Farmer cultivating soy 2014	41.44 (26.48)	41.17 (26.48)	-0.26	0.93
Distance to market for pesticides, fertilizer and seeds all year (km)	13.44 (10.57)	13.54 (10.23)	0.09	0.94
Distance to market for pesticides, fertilizer and seeds during season (km)	6.17 (6.48)	5.69 (6.11)	-0.48	0.54
Distance to bank or formal credit organization (km)	15.82 (10.83)	15.82 (11.94)	-0.12	0.93
Distance to closest market to sell produce (km)	5.8 (9.23)	4.39 (6.69)	-1.40	0.16
Distance to market for fresh fruits and vegetables (km)	2.83 (5.37)	2.77 (3.62)	-0.06	0.91
# of Visits by Government	5.92 (15.78)	7.04 (13.66)	1.12	0.54
# of Visits by NGO's	15.38 (26.27)	18.49 (30.17)	3.10	0.38
N			250	250

Table 13: Differences between marketing treatment and control villages at baseline

Variable	Mean (St. dev) Control	Mean (St. dev) Treatment	Difference in means (Treatment – Control)	P-value
Number of households	73 (6.52)	72 (7.24)	0.99	0.91
Distance to a paved road (km)	2.66 (0.45)	2.23 (0.42)	0.43	0.49
Distance to a national highway (km)	7.54 (0.93)	7.65 (0.86)	-0.10	0.93
% Area under soy cultivation 2014	22 (1.36)	25 (1.85)	-2.59	0.26
% Farmer cultivating soy 2014	42 (2.40)	39 (2.46)	3.07	0.37
Distance to market for pesticides, fertilizer and seeds all year (km)	13.59 (0.94)	13.40 (0.91)	0.18	0.88
Distance to market for pesticides, fertilizer and seeds during season (km)	5.30 (0.42)	6.55 (0.66)	-1.24	0.11
Distance to bank or formal credit organization (km)	15.23 (1.08)	16.27 (0.95)	-1.03	0.47
Distance to closest market to sell produce (km)	4.46 (0.64)	5.71 (0.78)	-1.25	0.22
Distance to market for fresh fruits and vegetables (km)	3.35 (0.45)	2.26 (0.35)	2.80	0.06
# of Visits by Government	6.49 (1.37)	6.46 (1.27)	0.23	0.98
# of Visits by NGO's	17.27 (2.29)	16.59 (2.74)	0.68	0.84
N			250	250

. To identify the impacts of the program, we cannot rely on a traditional regression approach. Note that while treatment and control villages are comparable, households are not comparable in treatment and control villages. This is likely due to the fact that in treatment villages, both club members and non-club members were sampled, specifically, we sampled 5 club members and 5 non-club members in each treatment village. This stratified sampling design has implications for the identification strategy.

First, we use the households in the treatment villages to predict club-membership in the control villages, creating a group of would-be club members (and the complementary group of would-be non-club members). Second, we compare club members in the treatment villages with would-be club members in the control villages. Specifically, using the midline data, we estimate the effect of the extension program for CDI club members as in (7.1) – where subscript *i* denotes the household and subscript *j* denotes the village.

$$y_{ij,club} = \alpha + \beta_{1,\mathrm{club}} D_j + \beta_{1,\mathrm{club}} E_j + \mu_j + \varepsilon_{ij} \qquad (7.1)$$

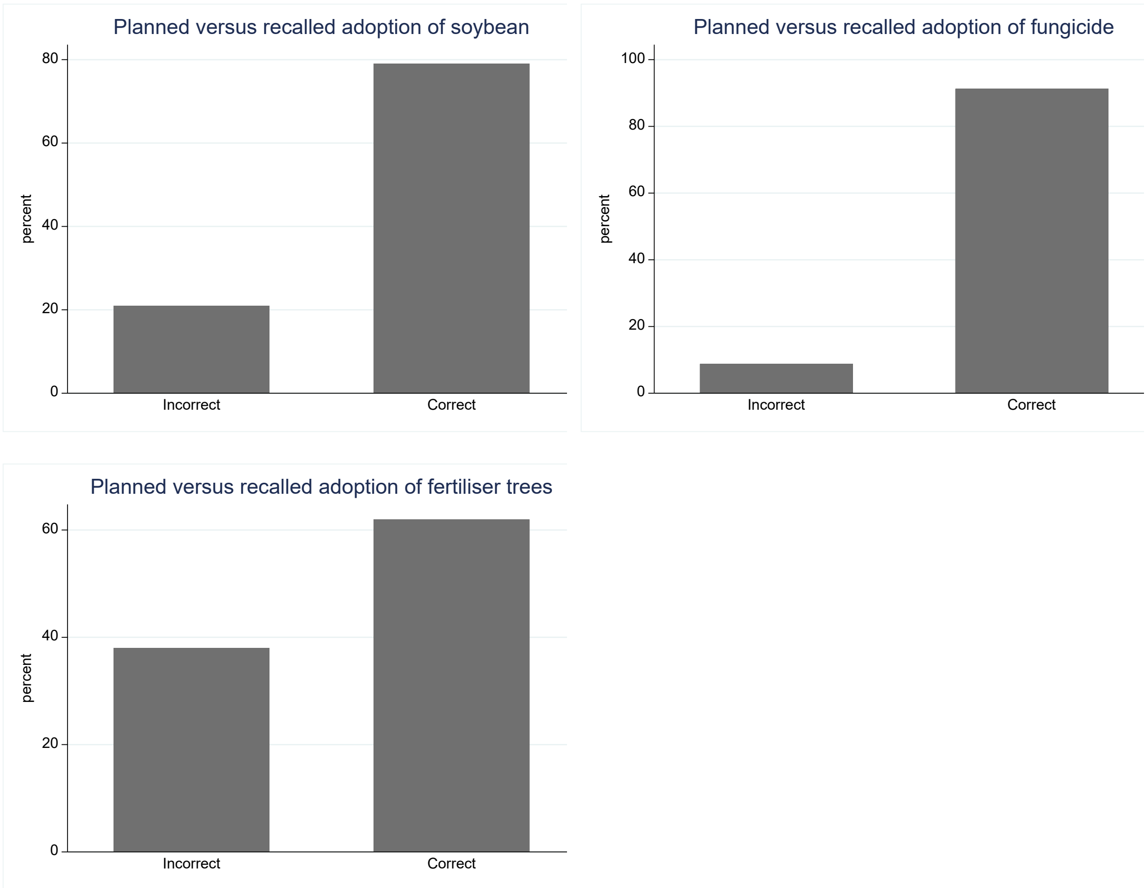
Where E_j = 1 if the village is an (extension) treatment village, and 0 otherwise and D_j=1 if the village had received a demonstration plot. Note that by considering the actual club members from the treatment group as treated, one might re-introduce sample selection bias. The degree of this bias would depend on how good our first-stage prediction is and the extent of self-selection and spill-overs. If spill-overs are limited, and self-selection significant and poorly predicted, this might result in an over-estimation of the treatment effects reported. More details on this step, including the list of control variables, and alternative specifications, are included in Maertens et al. (2019). We clustered the errors at the village level, and used a bootstrap procedure to account for the two stages in the estimation process (see Abadie and Imbens 2009). The dependent variables y_{ij} include the midline-elicited variables of planned adoption (2015-16 season) of soybean, inoculation of soybean, groundnut, hybrid maize, herbicide, pesticide, fungicide, inorganic fertilizer, fertilizer tree, intercropping, animal manure, crop residue and compost and whether or not each one of the questions in the knowledge test was answered correctly. We also compute an adoption score (out of 13) and knowledge score (out of 20).

Before we proceed, we should address the issue of using adoption plans instead of actual adoption in the analysis described above. This decision was data-driven. When we returned to the villages at midline, in 2015, the 2014-2015 agricultural season had just ended. As CDI's extension program also ran concurrently with this season, it could not have impacted the adoption choices in that same season (in effect, we reported a null effect on these (these results are available on request). However, our use of adoption plans versus actual adoption relies on the accuracy of the latter correctly representing the former. Using endline data, we are able to reflect on this accuracy. Overall, we have an accuracy rate ranging between 50% and 95%. The error is usually in the direction of lower planned adoption at midline (compared to recalled adoption at endline), except for with fertiliser tree and groundnut adoption. This direction of the error is the opposite of what one would expect: One would expect the plans to over-report the actions. Overall, if the recall is correct, and not the plans, this would hence result in an underestimation of the effect sizes using the midline data.

In Figure 4 we report the results of this exercise for selected technologies – the adoption of soybean, the adoption of fungicide and the adoption of fertiliser trees. One can see that few mistakes are being made when it comes to modern inputs, such as fungicide, but the planned and recalled adoption map up less well when it comes to labour and knowledge intensive technologies such as fertiliser trees.

Concerns about the recall data quality, and the fact that our main interest at midline was the learning process and intentions, drove us to stick with the adoption plans data at midline, rather than the recalled adoption for the same year as endline. In addition, as intentions usually precede actions, we considered this a useful first step (see also Maertens et al. 2019 for a discussion on these matters).

Figure 4: Comparing planned adoption with recall data of the 2015-16 cropping year



For the endline analysis, we estimate the effect of the extension and marketing program through specification (7.2). Again, subscript *i* denotes the household and subscript *j* denotes the village.

$$\Delta y_{ij} = \alpha + \beta_1 E_j + \beta_2 D_j + \beta_3 M_j + \Delta\varepsilon_{ij} \qquad (7.2)$$

In specification (7.2), Δ denotes the difference between endline (2018) and baseline (2014) . E_j = 1 if the village is an (extension) treatment village, and 0 otherwise; D_j=1 if the village had (ever) received a demonstration plot and 0 otherwise; M_j = 1 if the village is a (marketing) treatment village, and 0 otherwise. As correlation between observations can result in incorrect standard error estimates, we clustered standard errors at the village level to allow for arbitrary correlation between village members (see Cameron and Miller 2015).

We also considered interaction effects of the marketing treatment and the two extension treatments using specification (7.3):

$$\Delta y_{ij} = \alpha + \beta_1 E_j + \beta_2 D_j + \beta_3 M_j + \beta_4 E_j M_j + \beta_5 D_j M_j + \Delta\varepsilon_{ij} \qquad (7.3)$$

The dependent variables in specification (7.2) and (7.3) include the base and endline elicited variables of (actual) adoption of: soybean, inoculation of soybean, groundnut, hybrid maize, herbicide, pesticide, fungicide, inorganic fertilizer, fertilizer tree, intercropping and crop rotation, animal manure, crop residue and compost; crop yields of maize, soybean and groundnut; prices of soy, quality of soy and time of sales of soy and a measure of agricultural income. We have yet to expand our analysis to include crop rotation and planting density, as well as diet diversity (these cannot be studied using the fixed effect approach outlined above).

Note that this analysis does not include any additional time-variant independent variables. While there is no doubt that time-variant variables would play a role in determining these dependent variables, they key question is whether they would create omitted variable bias. In most cases, e.g. weather variables, it would not (see Wooldridge 2013).

7.3 Main results

Tables 14 and 15 present the results of regression specification (7.1). Table 14 presents the average treatment effect of the CDI extension program components on (planned) adoption of ISFM practices at midline. Table 14 shows that demonstration plot participation increases adoption of ISFM practices by 0.79 points, which is about 22 percent (Column (1)), while being invited to a field-day does not produce such (statistically significant) results. Columns (2) through (14) present the results of a series of linear probability models. We note that being a member of a demonstration plot club increases the probability of inoculating soybean (at the 5 percent level), using hybrid maize (at the 1 percent level) and planting fertilizer trees (at the 5 percent level).

Table 15 presents the average treatment effect of the CDI extension program components on knowledge at midline. Column (1) presents the effects on the knowledge score out of 20 - with one point for every question the farmer answered correctly. Columns (2) through (21) present the result of 20 linear probability models, taking as a dependent variable whether or not the farmer answered each of the 20 questions correctly. Participating in a demonstration plot improves knowledge. Table 15 reports an increase by 0.63 points, which is about 8 percent (P-value of 0.11), with statistically significant increases in knowledge of inoculation and pesticides in particular (note that we do spot a negative effect on question (14) - but the negative, tricky, formulation of that question cautions against over-interpretation). In contrast, being invited to a field-day does not (statistically significantly) alter one’s knowledge.

Table 14: The impact of the CDI extension program on (planned) adoption of ISFM technologies at midline

Linear and Linear Probability Model with Dependent Variables:

	Adoption (1)	**Soy (2)**	**Inoculation (3)**	**Ground-nut (4)**	**Hybrid Maize (5)**	**Herbicide (6)**	**Pesticide (7)**	**Fungicide (8)**	**Inorganic fertilizer (9)**	**Fertiliser tree (10)**	**Inter-cropping (11)**	**Animal manure (12)**	**Crop residue (13)**	**Compost (14)**
Demonstration plot	0.793**	0.054	0.166**	0.098	0.162***	-0.010	0.051	0.018	0.027	0.146**	0.068	-0.026	-0.007	0.048
	(0.334)	(0.050)	(0.068)	(0.067)	(0.054)	(0.052)	(0.063)	(0.049)	(0.046)	(0.072)	(0.060)	(0.081)	(0.075)	(0.048)
Extension treatment	0.059	0.069	0.029	-0.048	0.074	-0.065	-0.048	-0.037	0.019	0.054	-0.006	0.094	-0.042	-0.033
(Field-day)	(0.305)	(0.047)	(0.055)	(0.074)	(0.062)	(0.043)	(0.053)	(0.039)	(0.045)	(0.060)	(0.066)	(0.084)	(0.070)	(0.034)
Constant	5.435***	0.875***	0.106***	0.745***	0.780***	0.110***	0.149***	0.082***	0.902***	0.125***	0.804***	0.412***	0.278***	0.067***
	(0.232)	(0.038)	(0.034)	(0.046)	(0.046)	(0.034)	(0.036)	(0.028)	(0.031)	(0.034)	(0.042)	(0.050)	(0.044)	(0.025)
Observations	414	414	414	414	414	414	414	414	414	414	414	414	414	414

Notes: This table present the results of a series of linear regressions with dependent variables: adoption (score out of 13), soy (binary variable), inoculation soy (binary variable), groundnut (binary variable), hybrid maize (binary variable), herbicide (binary variable), pesticide (binary variable), fungicide (binary variable), inorganic fertilizer (binary variable), fertilizer tree (binary variable), intercropping (binary variable), animal manure (binary variable), crop residue (binary variable), and compost (binary variable). These refer to planned adoption in the 2015-16 season. The independent variables are whether or not the individual is in a club which managed a demonstration plot, and whether or not the individual is in a club which was invited to a farmer field day. The estimation uses a two-step procedure. The first steps uses the reported club membership at endline in the treatment villages to predict who would be most likely to join a CDI club. The second step uses all individuals in both treatment and control group whose predicted probability is larger than 0.5. This includes 241 individuals in the treatment group and 173 individuals in the control group. The control variables used in this first step include village level characteristics and household level characteristics (see Maertens et. al 2019) and baseline adoption indicators. Bootstrapped clustered errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 15: The impact of the CDI extension program on knowledge of ISFM technologies at midline

Linear and Linear Probability Model with Dependent Variables:											
	Knowledge	**K - Q1**	**K - Q2**	**K - Q3**	**K - Q4**	**K - Q5**	**K - Q6**	**K - Q7**	**K - Q8**	**K - Q9**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	
Demonstration plot	0.629*	0.014	0.189***	-0.003	0.107*	-0.004	0.102	0.059	0.036	-0.008	
	(0.397)	(0.086)	(0.063)	(0.041)	(0.065)	(0.003)	(0.083)	(0.078)	(0.075)	(0.053)	
Extension treatment	-0.140	0.018	0.070	-0.018	0.058	0.019	-0.038	-0.082	-0.065	-0.060	
(Field-day)	(0.354)	(0.083)	(0.076)	(0.037)	(0.057)	(0.019)	(0.074)	(0.081)	(0.068)	(0.042)	
Constant	7.871***	0.600***	0.682***	0.075***	0.122***	0.004	0.341***	0.655***	0.278***	0.094***	
	(0.227)	(0.054)	(0.047)	(0.024)	(0.032)	(0.003)	(0.047)	(0.049)	(0.046)	(0.035)	
Observations	414	414	414	414	414	414	414	414	414	414	
	K - Q10	**K - Q11**	**K - Q12**	**K - Q13**	**K - Q14**	**K - Q15**	**K - Q16**	**K - Q17**	**K - Q18**	**K - Q19**	**K - Q20**
	(11)	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**
Demonstration plot	0.138*	-0.010	0.036	0.085	-0.181**	-0.029	-0.001	0.025	0.049	0.051	-0.025
	(0.075)	(0.017)	(0.078)	(0.057)	(0.084)	(0.087)	(0.072)	(0.081)	(0.074)	(0.066)	(0.083)
Extension treatment	0.082	-0.019	0.002	0.026	-0.107	0.085	0.001	-0.001	0.025	-0.003	-0.134*
(Field-day)	(0.070)	(0.019)	(0.074)	(0.049)	(0.081)	(0.084)	(0.074)	(0.076)	(0.071)	(0.059)	(0.078)
Constant	0.176***	0.996***	0.278***	0.086***	0.624***	0.443***	0.729***	0.361***	0.694***	0.149***	0.482***
	(0.040)	(0.006)	(0.046)	(0.030)	(0.051)	(0.054)	(0.045)	(0.049)	(0.046)	(0.039)	-0.048
Observations	414	414	414	414	414	414	414	414	414	414	414

Notes: This table present the results of a series of linear regressions with dependent variables: knowledge (score out of 20), and the 20 knowledge questions listed in the midline questionnaire (binary variables). The independent variables are whether or not the individual is in a club which managed a demonstration plot, and whether or not the individual is in a club which was invited to a farmer field day. The estimation uses a two-step procedure. The first steps uses the reported club membership at endline in the treatment villages to predict who would be most likely to join a CDI club. The second step uses all individuals in both treatment and control group whose predicted probability is larger than 0.5. This includes 241 individuals in the treatment group and 173 individuals in the control group. The control variables used in this first step include village level characteristics and household level characteristics (see Maertens et. al 2019) and baseline adoption indicators. Bootstrapped clustered errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

These results suggest that the field-days were not very effective tools of technology dissemination and were confirmed in the focus group interviews. Demonstration plot participants by their own account learned a great deal about soy and maize cultivation. When asked about what they learned, participants could recount the various ISFM techniques utilized, and demonstrate to the research team how these could be implemented. Having harvested the demonstration plots, they had a good sense of the yields that could be obtained as well. The field-day participants highlighted the importance of using modern inputs, such as pesticides. But when pressed for details, could not recall the type of pesticide needed, nor how to use them.

Table 16 presents the results of regression specification (7.2), and Table 17 adds the interaction variable as per regression specification (7.3). The dependent variables in specification (7.2) and (7.3) include an adoption score, measuring the joint adoption of soybean, inoculation of soybean, groundnut, herbicide, pesticide, fungicide, inorganic fertilizer, fertilizer tree, intercropping, animal manure, crop residue and compost; the crop yield of soybean; the price of soybean, time of sales of soybean; and agricultural income as measured by revenues.

Again, the average treatment effects are presented. We note a statistically significant average treatment effect of being a member of a demonstration plot club. The effect size, 0.33, is about half the size of the effect estimated from base to midline. None of the other variables of interest are statistically significant, however it should be noted that the P-value on soy yield is relatively low. Table 17 presents the results of specification (7.3), i.e., including the interaction effects between the various program components. We again note the lack of interaction effects between the two program components.

Note the significant size of the year effects in both Tables 16 and 17, all of which are indicating an increase in adoption and prices, and improvement of yields over the years. This is suggestive of policy changes which affected both treatment and control groups, or changes in the natural environment. For instance, we know that the rainfall patterns differed substantially from year to year (see the agronomic report of our project available from the website).

In addition, one should exercise caution when interpreting these results. Recall that in the case of extension treatment and marketing treatment, the estimates presented are intent-to-treat effects. In the case of the extension treatment, these should be interpreted as the (average) effect on a farmers' club which is invited to attend field-days; and, as most clubs did attend, this approximates the (average) effect on a farmer's club for which at least one member does attend. However, the analysis presented in this report does not look at the underlying heterogeneity between club members who attend versus the ones that do not (Maertens et al. 2019 goes in more detail). Similarly, in the case of the marketing program, this captures the (average) effect of being assigned to the marketing program. However, in this case, many of the villages who were assigned to the treatment ended up not being invited to attend the information session in 2017-18, fewer attended the information session in 2017-18 and only in only two villages did farmers actually sell through CDI. Figure 7.12 breaks down the numbers, by district.

Table 16: The impact of the CDI extension and marketing program on adoption, yields, prices, time of sales, and revenues at endline

	Adoption score	Soy yield [50 kg/acre]	Price of soy [MK/50 kg]	Revenues [MK]	Time of sales
	(1)	(2)	(3)	(4)	(5)
Demonstration plot	0.338**	1.255	-367.980	1,427.492	-0.926
	(0.167)	(1.171)	(670.852)	(78,320.934)	(0.912)
Field-day	0.109	-0.649	-749.240	58,333.732	-0.528
	(0.175)	(1.696)	(701.403)	(76,905.566)	(1.157)
Marketing program	-0.010	0.227	697.900	86,629.832	1.352
	(0.180)	(1.329)	(640.138)	(101,481.840)	(1.022)
Year	2.615***	2.245***	6,226.160***	97,206.180***	-5.285***
	(0.054)	(0.576)	(429.264)	(18,170.682)	(0.359)
Constant	3.031***	18.452***	4,323.869***	173,626.518***	32.606***
	(0.024)	(0.281)	(215.795)	(10,502.020)	(0.202)
Observations	4,378	2,267	1,949	3,727	1,948
R-squared	0.682	0.042	0.441	0.022	0.412
Number of households	2,189	1,621	1,504	2,100	1,504

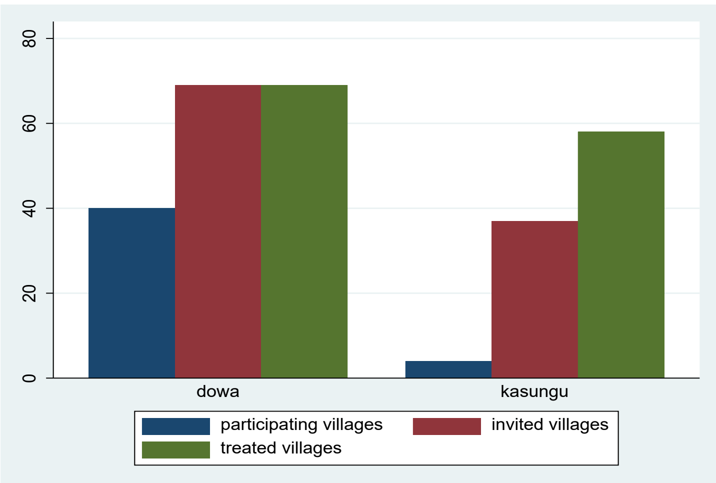
Notes: This table present the results of a farmer fixed-effects regression with dependent variable (xtreg, fe) using regression specification (7.2). Robust-clustered standard errors in parentheses. The time of sales is in weeks since 1 Jan. Whether or not farmer is in a club is determined by the self-reported club status in 2018.*** p<0.01, ** p<0.05, * p<0.1.

Table 17: The impact of the CDI extension and marketing program on adoption, yields, prices, time of sales, and revenues at endline

	Adoption score	Soy yield [50 kg/acre]	Price of soy [MK/50 kg]	Revenues [MK]	Time of sales
	(1)	(2)	(3)	(4)	(5)
Demonstration plot	0.355*	0.655	-523.501	79,690.528	-0.658
	(0.193)	(1.258)	(734.613)	(81,265.631)	(1.064)
Field-day	0.097	0.815	-468.527	-28,787.564	-1.228
	(0.215)	(2.476)	(754.698)	(59,238.945)	(1.648)
Marketing program	0.032	2.769	815.641	81,070.225	0.472
	(0.560)	(1.749)	(1,688.371)	(109,059.884)	(2.157)
Interaction variables					
Demonstration plot *	-0.079	-1.069	191.827	-164,936.542	0.319
Marketing program	(0.628)	(2.546)	(1,947.239)	(167,038.621)	(2.577)
Field-day *	-0.022	-4.812	-536.108	152,167.209	1.910
Marketing program	(0.608)	(3.010)	(1,952.755)	(213,653.487)	(2.792)
Year	2.615***	2.212***	6,224.359***	97,279.212***	-5.272***
	(0.054)	(0.585)	(433.462)	(18,377.391)	(0.361)
Constant	3.031***	18.448***	4,321.836***	173,731.573***	32.612***
	(0.024)	(0.281)	(215.588)	(10,456.390)	(0.201)
Observations	4,378	2,267	1,949	3,727	1,948
R-squared	0.682	0.044	0.441	0.024	0.413
Number of households	2,189	1,621	1,504	2,100	1,504

Notes: This table present the results of a farmer fixed-effects regression with dependent variable (xtreg, fe) using regression specification (7.3). Robust-clustered standard errors in parentheses. The time of sales is in weeks since 1 Jan. Whether or not farmer is in a club is determined by the self-reported club status in 2018.*** p<0.01, ** p<0.05, * p<0.1. This table uses regression specification (7.3). Robust-clustered standard errors in parentheses.

Figure 5: Number of treated, invited and participating villages to the marketing information meetings in 2017-2018, by district



In Table 18 we present the results of an alternative specification. Recall that some CDI clubs managed a demonstration plot for more than one year. In Table 18 we investigate a specification which takes into account the intensity of this treatment and splits the demonstration plot treatment into two treatments: (1) Manage a demonstration plot only once; and (2) Manage a demonstration plot more than once.

We note that the demonstration plot effect noted in Tables 16 and 17 was driven by the villages who had just one demonstration plot. However, the difference in the adoption score between the two sets of villages is not statistically significant. Again, one has to be careful in interpreting these results. The last set of demonstration plots, in 2017-18, were very different in set-up. While the demonstration plots in earlier years were small, displayed various treatments, and regularly visited by the CDI extension agent; the demonstration plots in 2017-18 (called farmer gardens by CDI) were large, had only one treatment, and were guided by a local farmer, called a hub farmer. As this demonstration plot program drastically expanded in the last year, the effect of the expansion can hence not be distinguished from the effect of the change in this design.

Table 18: The impact of the CDI extension and marketing program on adoption, yields, prices, time of sales, and revenues at endline

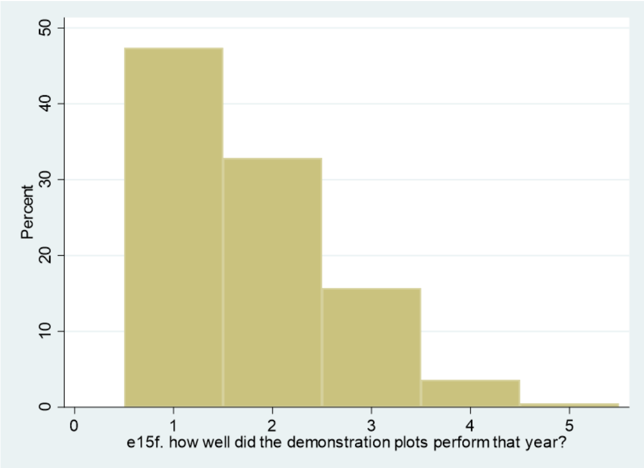
	Adoption score	**Soy yield [50 kg/acre]**	**Price of soy [MK/50 kg]**	**Revenues [MK]**	**Time of sales**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**
Demonstration plot = 1	0.385*	-0.102	-248.184	98,687.108	0.297
	(0.208)	(0.774)	(814.159)	(98,399.409)	(1.569)
Demonstration plot >1	0.294	2.842	-438.145	-94,480.639	-1.616*
	(0.231)	(2.037)	(800.316)	(116,470.209)	(0.840)
Field-day	0.103	-0.362	-755.541	43,592.163	-0.585
	(0.177)	(1.758)	(700.460)	(77,890.132)	(1.142)
Marketing program	0.000	-0.238	707.574	112,019.466	1.439
	(0.185)	(1.444)	(638.146)	(110,296.659)	(0.983)
Year	2.615***	2.251***	6,226.012***	96,872.654***	-5.286***
	(0.054)	(0.576)	(429.367)	(18,190.950)	(0.359)
	3.031***	18.445***	4,322.665***	173,690.239***	32.593***
Constant	(0.024)	(0.282)	(215.798)	(10,483.774)	(0.203)
Observations	4,378	2,267	1,949	3,727	1,948
R-squared	0.682	0.044	0.441	0.023	0.414
Number of households	2,189	1,621	1,504	2,100	1,504

Notes: This table uses a variation of regression specification (7.1). Robust-clustered standard errors in parentheses.

In addition to the length of exposure to the extension treatment, the demonstration plot performance also varies by village, due to differences in soil, rainfall, and implementation. Figure 6 illustrates this point: this is the histogram of the endline question – how did your demonstration plot perform that year. While the answer here is subjective (we do have the objective measure as well), it is informative, as it shows how farmers perceive the performance and it is arguably this perception, and not necessarily the reality, which will drive their behaviour. We note that while most demonstration plots did well, there were some that did quite poorly, and this might affect not only the farmers involved but the rest of the village as well negatively. We explore this issue further in

Maertens et al. (2019) and in Table 19 below. Details on the actual performance of the demonstration plots are included in the project's agronomic reports, available from the project's website.

Figure 6: Histogram of perceived demonstration plot performance, all years



1 "very well" 2 "well" 3 "poorly" 4 "very poorly" 5 "variable"

Table 19: Correlates of knowledge for demonstration plot farmers at midline

OLS Regression of knowledge score				
	Soybean		**Hybrid Maize**	
	(1)	**(2)**	**(3)**	**(4)**
Yield on BPA subplot on local demonstration plot [in 50 kg bags/acre]	0.042		0.018**	
	(0.028)		(0.007)	
Start of the rain (days)		-0.018		-0.005
		(0.012)		(0.009)
Total amount of rain (mm)		0.001		0.001
		(0.001)		(0.001)
Number of times flood (flood = more than 50 mm/1 day)		-0.221		-0.152
		(0.127)		(0.279)
Observations	61	68	101	101
R-squared	0.115	0.213	0.213	0.183

Notes: This table presents the results of a linear regression with dependent variable: Knowledge score at endline. Columns (1) and (2) refer to soybean and Columns (3) and (4) to hybrid maize. The knowledge score for soybean is a number out of 6, while the knowledge score for hybrid maize is a number out of 8. Columns (1) and (3) consider use yield on the BPA subplot as the main independent variable of interest, which refers to the maximum yield on the BPA subplots on the local demonstration plot. Columns (2) and (4) consider various rainfall aggregates as the main independent variables. Other control variables included but not reported: Gender household head, age household head, education household head (years), number of household members, number of adult household members, maximum education level in the household, acreage of land owned, value of all assets (excluding land), relevant yield expectations at baseline, and whether the household cultivated hybrid maize in 2013-14 (for Columns (3) and (4) only). Sample includes the club farmers in the demonstration plot villages. Whether or not farmer is in a club is determined by the self-reported club status at midline. Village-clustered errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

In Table 19 we plot the relationship between demonstration plot yields and learning, as measured through the crop-specific knowledge score for the demonstration plot participants (including a series of control variables). We find a statistically significant, and positive, relationship between the yields measured, and the average learning of the demonstration plot participants (soybean is almost statistically significant at the 10 percent level) - in Columns (1) and (3) for both soybean and hybrid maize. The magnitude indicates that an increase in 50 kg/ha increases the knowledge by approximately 5 percent (relative to the average score).

To interrogate the causal interpretation of the results, Columns (2) and (4) present the results using attributes of the demonstration plot rainfall rather than plot yields. Indeed, reverse causality could explain the results presented in Columns (1) and (3): farmers with better knowledge have better results. Rainfall, on the other hand, does not suffer this critique and is correlated with crop development. We defined three statistics of the distribution: start of the rainy season, the total amount of rainfall, and the number of flood days (defined as > 50 mm/day). The latter, in particular at the start of the season, can be quite damaging for germination. We note the hypothesized correlation between rainfall patterns and knowledge of soybean (but no such correlation for hybrid maize, which suggests that either rainfall and germination rates were not as closely related, or farmers' learning was more uniform across the various plots, perhaps because maize is a historically important crop).

We move on with a note on the nature of the marketing program. So far, the results indicated that this program had not been very effective in raising prices. However, a more careful analysis reveals two important considerations.

First, very few households participated in the marketing program—i.e., few sold soy through CDI. In effect, there were only two villages that participated (corresponding to 12 households in the sample). During qualitative interviews farmers noted that the marketing program of CDI came through fairly late in the season, and many of them were pressed for cash, and hence forced to sell before they could participate. Others noted their willingness to wait, but an inability to meet the aggregation requirements set by CDI. This is confirmed in our endline interviews as documented by Table 20.

However, as suggested by Figure 5, significantly more villages were aware of the program. As Table 20 notes, as many as 10% of households in the endline sample who sold soybean were aware of CDI's marketing program. Recall that besides offering a marketing channel for soybean, the program also offered information on local market prices of all main crops that season via SMS. Qualitative interviews suggest that it is this component which might have had unintended, but beneficial effects. As a response to this information, farmers were able to postpone selling, thereby identifying better markets, or at the minimum obtain a better price by delaying the sales.

Table 21 provides some evidence in this direction. This specification was not planned at the time of the midline analysis plan, but deemed useful as a response to the qualitative interviews. Table 21 presents the average treatment effect of the CDI marketing program on the price of maize at endline. A variation of specification (7.3) is used. We note that, conditional on CDI club membership, attending CDI's marketing sensitization meetings in 2018 increased the price of maize by, on average, 1,636 MK/50 kg. This is an effect size of about 37%. Note that this effect is independent of whether or not the CDI club in question ran a demonstration plot that year (in 2017-18, recall these were called farmer gardens).

Table 20: Participation in CDI's marketing program in 2017-18

Did CDI facilitate this market transaction?	12 out of 1560
Were you aware that CDI had buyers in selected villages?	10% of households
Why did you not opt for the CDI facilitated buyer?	In % of households who were aware
Did not manage to get produce to the required depot	17
Did not meet quantity standard	2
Need to sell urgently	47
Other reason	31

Note: This table is derived from the endline household questionnaire and only pertains to the households who produced and sold soy in 2017-18

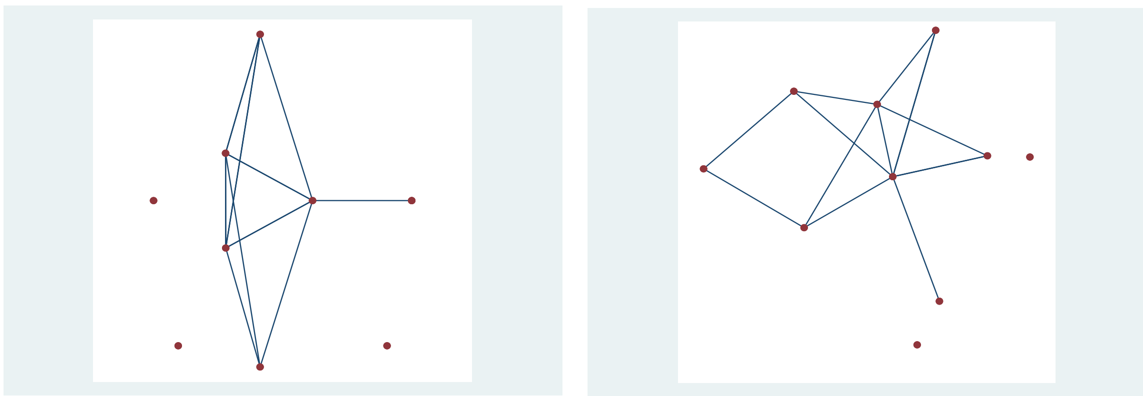
Table 21: Impact of the CDI marketing program on farmers' output price of maize at endline

Panel Estimation: Dependent Variable: Price of maize (MK/50kg)	
	Price
Participated in sensitization meetings of CDI in 2017-18	176.597
	(469.275)
CDI club member in 2017-18	-1,166.557
	(801.999)
Participated * CDI club member	1,636.041*
	(945.870)
Farmer garden in village in 2017-18	2,851.904*
	(1,518.435)
Farmer garden in village * Participated	-3,270.753**
	(1,552.491)
Farmer garden in village * Participated *CDI club member	-410.718
	(791.065)
Year	2,083.919***
	(407.745)
Constant	3,257.717***
	(147.487)
Observations	654
Number of households	327
R-squared	0.146

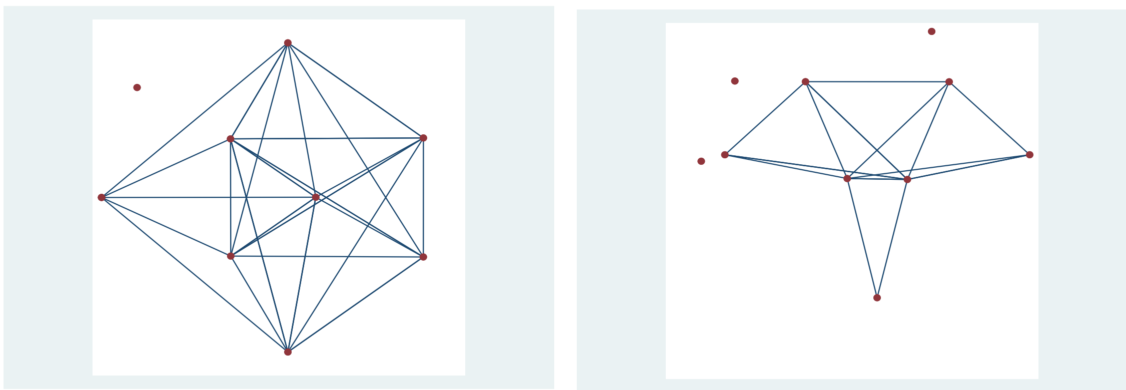
Notes: This table present the results of a farmer fixed-effects regression with dependent variable (xtreg, fe): Output price of maize (in MK/50 kg bag). Whether or not farmer is in a club is determined by the self-reported club status in 2018. Robust-clustered standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Includes only farmers who sold maize in both base and endline.

We conclude this sub-section with a note on the social networks in the village. While we have yet to complete a full analysis of the social networks, preliminary analysis indicates that the CDI program might be altering the underlying networks. Figure 6 plots the social network in two demonstration plot villages, corresponding to the question “Did you ever ask X for advice on agriculture in the last 12 months?” We note an increase in network links from base to endline in both villages. This might be due to the fact that the non-club farmers start reaching out to the club farmers for information. But, it can be also due to the fact that the CDI club itself was quite fluid with people leaving and joining the clubs each year. In effect, in the village on the left, this appears what has mostly happened. The individuals who were isolated in the top panel were members of the club in the bottom panel.

Figure 7: Changes in social networks from base to endline in two selected villages



Panel A: Baseline network graphs on Tembo in Chibvala (left) and Mkanda in Kasungu (right)



Panel B: Endline network graphs on Tembo in Chibvala (left) and Mkanda in Kasungu (right)

7.4 Heterogeneity analysis

We identified two dimensions of interest. In Table 22 we explore heterogeneity of the midline impacts according to the sex of the head of the households using specification (7.1). Recall that the sample only contains 18% female-headed households. However, as women might face a different set of labour and cash constraints compared to men (see, for instance, Kondylis et al 2017), establishing impact by sex is important.

Table 22 finds that the effect of demonstration plots among female-headed households might be substantially higher than the effect on male-headed households. The effect of field- days is insignificant for both groups.

Table 22: The impact of the CDI extension program on (planned) adoption and knowledge of ISFM technologies at midline – by sex of the household head

	Male-headed households		**Female-headed households**	
	Adoption (1)	**Knowledge (2)**	**Adoption (3)**	**Knowledge (4)**
Demonstration plot	0.675***	0.447	1.13**	1.850***
	(0.248)	(0.458)	(0.51)	(0.525)
Field-day	-0.123	-0.259	1.06	0.507
	(0.248)	(0.313)	(0.071)	(0.997)
Constant	5.626***	7.981***	4.43***	7.292***
	(0.148)	(0.193)	(0.434)	(0.366)
Observations	356	358	58	58

Notes: This table uses regression specification (7.1A). The same notes as in Tables 14 and 15 apply. Robust-clustered standard errors in parentheses.

In Table 23 we present heterogeneity results by baseline soil fertility using specification (7.1). Note that this is a critical source of variation that is generally unobserved (and therefore generally left out of analyses). However, because application of external inputs has been found to be considerably less effective on soils of poor quality and because farmers likely know or suspect the quality of their soils, it is critical to have measures of soil fertility to properly analyze adoption and the effects of adoption of new agricultural technologies. Moreover, because poor quality soils are often correlated with low-household wealth, failure to control for these often-unobserved variables can lead to faulty inference about why a household has failed to adopt a new agricultural technology. In Table 23 we use active carbon self-reported soil fertility as we have this measure for every household in the sample (Results for using the actual soil fertility measure are available on request). We find a evidence that the effect of the program might be higher for households with higher baseline soil fertility.

Table 23: The impact of the CDI extension program on (planned) adoption and knowledge of ISFM technologies at midline – by baseline soil fertility status

	High soil fertility		**Low soil fertility**	
	Adoption (1)	**Knowledge (2)**	**Adoption (3)**	**Knowledge (4)**
Demonstration plot	1.157**	1.229	0.000	0.937
	(0.450)	(0.818)	(0.718)	(0.772)
Field-day	-0.143	-0.021	-0.075	0.737
	(0.458)	(0.601)	(0.439)	(0.682)
Constant	5.143***	7.771***	7.875***	5.063***
	(0.375)	(0.550)	(0.435)	(0.639)
Observations	69	69	61	61

Notes: This table uses regression specification (7.1A). The same notes as in Tables 15 and 15 apply. Robust-clustered standard errors in parentheses.

Note that due to the limited uptake of the marketing treatment at endline, we limit the heterogeneity analysis in this report to the midline data only. We do intend to further explore the details of the marketing constraints using the endline data collected. In

Maertens et al. (2019) we also explore heterogeneity in the learning process by starting beliefs about expected costs and benefits of ISFM.

7.5 Cost of CDI's program

We communicated with CDI on the cost of the program they implemented. The salary of a government extension agent was about 187 USD/month at the time of our study; CDI pays a little more. CDI did not divulge the exact amount, and we used an estimate of 250 USD/month in our computation below. In addition to labour costs, field-days and demonstration plots also require other inputs as per Table 24 below.

A back-of-the-envelope calculation demonstrates that the per-farmer cost difference is substantial between a field day and a demonstration plot; in our study, hosting one farmer-field day for around 200 farmers costs about 650 USD total, or about 3.25 USD per farmer (we used the number of field-day participants in Mthumthama for this estimate), while organizing one demonstration plot for about 20 farmers costs 281 USD, about 14 USD per farmer. To establish the rate of returns for these program components, one would need to convert the adoption benefits to monetary values. While we find no significant effects on revenues as of yet, sustained adoption is likely to lead to increased yields and revenues (as in Adolwa et al. 2019).

The costs of the marketing component are more difficult to compute, as they involve the time spend negotiating contracts with the buyers, and the marketing program was effectively executed by the hub farmer who was not being paid for his time and effort. Nor did the farmers receive any compensation to attend the meetings, in terms of meals or transport. Hence, at face value, this program was the least expensive for CDI. However, if one accounts for the hub farmer's time, and compensates the farmers at the same rate as the field-days, the cost could amount to about 120 USD/per club, or 6 USD/farmer (again assuming 20 farmers per club).

Table 24: Cost of CDI's program components

Field day inputs (per field day)	Total (MWK)	Total (USD)
Meals for farmers	107000	149
Transport for farmers	360000	500
Per diems (GVT extension officers)	40000	56
Subtotal	507000	704
Demonstration plot inputs (per demonstration plot)		
Maize	5000	7
Soybean	3800	5
Fertilizer	5000	7
inoculant	2500	3
Harness (herbicide)	8000	11
Roundup (herbicide)	6000	8
Cypermethrin	4000	6
Folicur	6500	9
Fuel for supervision	95000	132
Subtotal	135800	189
Market sensitisation meetings (per club)		
Cost of SMS messages (15 MK per message)	240	0.31
Hub farmer salary	0	0
Transport and meals for farmers	0	0
Salary costs (in days)		
Total number of days for organising/planning a field day		5
Total number of days supervising one demonstration plot		8
Total number of days spent on marketing sensitisation meeting		1
Total number of days spent on sharing marketing information		4
Transportation costs		
Fuel costs for motorbike (monthly allowance)	130000	170
Cost of one motorbike	3,500,000	3500

Notes: These estimates were obtained from CDI, and used an exchange rate as of October 2018. The Demonstration plot inputs are for a 10 by 10 Soybean-Maize demonstration plot. Note that the CDI extension agent is expected to visit the demonstration plot twice per month during the growing season.

8. Discussion

In section 7, we presented the main results of the project. In this section, we review concerns related to internal and external validity. First, let us review the elements we are not concerned about. Our research team did an excellent job selecting (stratified) random samples from the 250 villages. As these represent the large majority of the villages in the two EPAs, we are confident in our descriptive statistics, whether baseline or endline. Along the same lines, we carefully pretested all the data instruments. For each data collection round, we started with structured qualitative interviews, which guided us in the formulation of the questions. Then, we pre-tested the questionnaire among non-sample households. Then we discussed the questionnaire with the large team of enumerators; and finally, in the field, during the actual data collection, we had correction mechanisms in place. For instance, we had a team What's App group for the survey where any enumerator could share any doubt or feedback. The researchers, supervisors and other enumerators could then come together and jointly formulate a solution. This lengthy but thorough process ensures data quality; something of particular importance when working with self-reported data as outcome variables.

We noted attrition in the sample. The endline attrition rate is 12%, which was in line with our assumptions in the project proposal. Specifically, there are 312 households present at the baseline who were not present during the endline survey. The households who left the sample are well distributed geographically; they come from both districts and from both treatment and control groups. They have household heads who are slightly younger (0.001 years – significant at the 10% level) and have somewhat higher access to credit (significant at the 10% level) but do not differ in terms of household composition and asset wealth. (These results are available on request.)

Contamination between villages was not a major concern in our study. Recall that the program components were implemented at the village level. While, as the baseline report noted, there was some contamination at the very early stages of the program, the lack of follow up in those control villages resulted in a fizzling out of the clubs who were initially formed in control villages. We do have within-village spill overs, and had set up the sample in such a manner as to be able to study these. However, preliminary analysis of these indicated that the CDI program appears to be altering the underlying networks. In future analysis, we intend to use the tools of social network analysis to shed further light on these spill overs and changes in networks. We expect spill-overs to be present (see, among others, Foster and Rosenzweig 1995, Conley and Udry 2010, Maertens 2017, Vasilaky and Leonard 2017 for evidence on learning spill-overs among farmers). Approaches such as BenYishay and Mobarak (2018) and Beaman et al. (2018) which consider the structure of the network and identity of network nodes already give promising results.

We do not expect Hawthorne effects, demoralizing effects or John Henry Effects to play a major role in the between village comparison; as only a small share of the households in the control villages were aware of the program CDI was implementing. So we do not expect the comparisons between treatment and control to result in individuals feeling singled out by the interventions in an either positive or negative manner. However, the within-village comparison might suffer from this; as households in treatment villages who were not part of the CDI club might regret not participating, or would have liked to participate in the first place.

As the farmers in this region are familiar with the concept of research studies we do not expect survey effects to play an important role, or at least not to differ across treatment groups. As the respective groups will not be informed of further roll-out plans (past year five), we do not expect anticipation effects to play an important role either.

In terms of research findings, we note that overall, there was excellent alignment between the quantitative and qualitative findings; in effect, it was often the qualitative findings which suggested a particular approach, or a detail to be captured in the questionnaire.

In terms of external validity, we previously mentioned that our study area covered almost all villages within two EPAs, and as such, is representative of these EPAs. At the time of the baseline, these two EPAs were similar to the other EPAs in the two districts they were drawn from. Table 25 makes the comparison. Note that our study EPAs are similar in terms of the number of households, percentage of female-headed households, and dependency ratio. We do note a slightly higher poverty headcount in the study EPAs.

Table 25: EPAs covered by the CDI project, descriptive statistics

	Dowa and Kasungu EPAs	
	New CDI project EPASs	**Existing Project EPAs**
Total households in EPA (EPA mean)	22,299	28,347
Female headed households (share)	22.45	23.59
Dependency ratio (dependents per working-age household member)	0.95	0.95
Population density (per sq km)	107.49	108.94
Poverty headcount	57.57	50.18
Ultra poverty headcount	29.92	22.92

Source: Malawi Government and World Bank, 2007

External validity not only relates to the representativeness of the study area with respect to a larger area, but also regarding the issues the research is trying to address. In this sense, our study is certainly representative. One of the main goals of the program is to encourage the adoption of integrated soil fertility and management practices. The issue of soil degradation is one faced by most of Sub-Saharan Africa, where soil fertility is low and declining (see, among others, Tully et al. 2015 and Njoloma et al. 2016, Sanchez 2002). Hence, the benefits of ISFM in terms of increasing average yields and reducing yield variance can be substantial (see, among others, Kerr et al. 2007, Dufflo et al. 2008, Sauer and Tchale 2009, Fairhurst 2012, Bezu et al. 2014, Franke et al. 2014 and Manda et al. 2015, Droppelman et al 2017), albeit heterogeneous, and conditional on farmer wealth and assets (see, among others, Marenya and Barrett 2007, Mugwe et al. 2009, Place et al. 2003, and for a critical review Vanlauwe and Giller 2006).

A further set of challenges include the lack of smallholder farmer participation in output markets, the phenomenon of "selling low and buying high", and the output price volatility to which smallholder farmers are exposed. These are all well documented in the Sub-Saharan African context (Stephens and Barrett 2011; Aggarwal et al. 2017; Burke et al. 2019). Many solutions have been proposed, such as linking farmers with supermarkets, encouraging contract farming, and introducing index insurance or improving credit markets. However, in the African context, few of these have been tried and even fewer have been tested.

The conclusions we have drawn from this study, summarized in the next section, can potentially be applied to other contexts of smallholder farmers in Sub Saharan Africa. Our results suggest the importance of measuring certain key variables that are usually unobservable, particularly soil quality. As noted in the heterogeneity analysis, it is the households who already have better soils who are more willing to adopt additional soil-improving technologies. In addition, it might be useful to measure beliefs of farmers, even though we struggled to measure yield expectations accurately: many farmers had trouble with the normalization to one acre, and farmers often did not know their own acreages. We would recommend that future researchers either measure farmers' plots by GPS or simplify these questions dramatically.

The mixed method approach we adopted, iteratively visiting the households with qualitative, agronomic, or quantitative data instruments was the cornerstone and strength of this study. Without this iterative process, we would have not become aware of some of the heterogeneities and nuances. For instance, during qualitative interviews we noted that women had a differential preference for soil improvement compared to men. Women considered the worst soil, and wanted to make that soil better to reduce variability. Men, on the other hand, were only willing consider their best soil for soil improvement, and often only when the plot was being used for cash crops. This heterogeneity is also picked up in our impact evaluation, were we noted a larger impact of extension programs on female-headed households compared to male-headed households. For both sets of households, the main results of the extension program evaluation hold: demonstration plots are considerably more effective tools of information dissemination compared to farmer field days. These results have been collabourated in recent research, such as, Dufflo et. al. (2006), Kondylis et al. (2017) and Lunduka et al. (2018).

A unique feature of our study is that the research findings were presented to the farmers and other stakeholders in the area. At the time of the endline data collection, we visited all 2500 farmers and shared with them a yearly calendar with various ISFM tips and techniques. These were well received by farmers, even though we did hear some reports of our calendar being sold on the market, perhaps indicating its value. In addition, we held workshops in the villages where we had collected soil samples. The farmers were thrilled to have these, and we held two-to-three-hour-long, lively discussions about the various soils in the villages, and which techniques farmers can apply to better their soils. The latter were so successful, we were asked by local NGOs and government extension agents to also share the results with them. We proceeded to hold workshops for these stakeholders in each EPA presenting mostly descriptive statistics in terms of households' characteristics, current agricultural technologies employed and the soils in the region. Finally, we also held an endline workshop in the capital Lilongwe, where we had other research organizations in addition to practitioners and farmers attending. This was where we presented the results of this report. The results presented were in accordance with the expectations, that is, at least the impact results were. However, the descriptive statistics in terms of soils (poor), beliefs regarding ISFM practices (somewhat pessimistic at first), and community cooperation did surprise some participants and gave rise to lively discussions.

We have two points of advice for researchers hoping to embark on similar studies. The first regards measurement. As noted earlier, despite our best efforts in pre-testing, we struggled with some of the measures that usually work well in these contexts—in particular with yield expectations and with time and risk preferences. We hypothesize that the low level of education, and the relative unfamiliarity with research and quantitative questions among our study population, played a role. As a response to these issues, we added explicit measures of numeracy and used simpler questions to measure these expectations and preferences. We concur with recent research of Chuang and Schechter (2015) and note the importance of well-designed survey questions. This is not to say that lab-in-the-field games cannot be useful. We found them immensely useful at baseline to shed light on club cooperation and communication through a public goods game.

The second point of advice regards the relationship with the implementing partner. As noted in the results section, the impact evaluation of the marketing pointed at null effects, largely due to implementation issues (the program came late, and had certain design issues), and perhaps relatedly, the lack of update on the farmers' end. These issues point at the importance of realistic expectations among both implementing agencies and researchers. Rolling out a marketing program in a country such as Malawi with poor infrastructure, monopsony power and a dysfunctional minimum price system was going to be challenging. In addition, given the need to aggregate and generate economies of scale, the act of randomization partially destroys the scale efficiency, thereby affecting external validity. During the study, both the research team and the implementing agency's team became gradually aware of these challenges. A critical review, and perhaps analysis of secondary data, could have prepared us better. Hence we would recommend other researchers to try to carve out perhaps up to one year prior to program design and baseline, as this might avoid some of these types of frustrations.

This failure also points at the difficulty of implementing marketing programs in developing countries. However, it is marketing and infrastructure, which we identified as the next frontier in terms of programs and evaluations. We would recommend other researchers to not just look at one Sub Saharan Country, but set up studies in multiple countries, to contrast their experiences. Given the scale of marketing, and the difficulty in randomizing meaningful marketing programs at the village level, we would recommend different evaluation designs and collaboration with a national partner, such as the government.

9. Specific findings for policy and practice

In this final section, we summarise the results of our study and draw implications for policy-makers and practitioners.

9.1 Summary of the results

We began our analysis by establishing the impacts of CDI's extension program, which included on-site demonstration plots and farmer field-days on the topic of Integrated Soil Fertility and Management Technologies.

9.1.1 Midline findings

One year after this program was implemented, we found that farmers who participate in demonstration plots planned to adopt around, on average, 22 percent more of the recommended ISFM technologies compared to similar farmers in control villages. Farmers who were invited to participate in a field-day, on the other hand, did not plan to adopt more of the ISFM technologies relative to similar farmers in the control villages. Our analysis suggests that the lack of planned adoption might be due to a lack of learning: One year after the program was introduced, farmers who participated in demonstration plots scored, on average, 8 percent higher on a test measuring knowledge of ISFM, compared to similar farmers in control villages. Farmers who attended a field-day did not score any higher compared to similar farmers in control villages. We confirmed these results through focus group interviews: while field-day attendees had become more aware of technologies, they did not learn the details of the production process to a degree that they felt they could replicate or implement them. Demonstration plot farmers, on the other hand, could recount and illustrate the various ISFM techniques taught. We refer the reader to Maertens et al. (2019) for further details of the midline data.

9.1.2 Endline findings

Five years after the extension program was implemented and comparing demonstration plot farmers over time with other farmers, we note a difference in adoption of ISFM practices of around 11 percent, still substantial but less. The latter is due to the heterogeneity of the demonstration plot farmers at endline: While some farmers were conducting demonstration plots year after year, others managed demonstration plots for only one year. Demonstration plots themselves varied also in quality, with some better managed than others, and some doing better, in terms of yields, than others.

In year four of our study, CDI introduced the output marketing component of the program. As with the extension component, introduction of the program was randomized across villages. This program however faced significant implementation constraints. Few of the villages in Mthumthama who were on the treatment list were informed about the program and while most of the treatment villages in Chibvala were successfully reached, very few farmers took up the CDI-offered sales contracts for soy. Farmers who took up the offer did receive a significantly higher price, but the number of farmers is too few for meaningful statistical analysis. Our qualitative results point at presence of two constraints to participation. First, the CDI-arranged buyer required a minimum quantity for sales. This quantity often exceeded what farmers in one village were able to achieve. Second, the CDI-arranged offer was only better than the prevailing market price towards the end of the sales season, by which time most farmers' credit constraints had driven them to sell on the open market. The CDI program did have one unintended, positive, side effect. Farmers who were informed about the program also received information on prevailing market prices of the main crops, in nearby markets, on a weekly basis. The act of providing this information appears to have encouraged some farmers to postpone sales and/or to scope out some new markets. In effect, comparing farmers who were aware of the program, with farmers who were not, over time, the former received an, on average, 18% higher price for maize, the main food crop in the region.

9.2 Implications for practice

We present our recommendations for NGOs and other organisations interested in engaging in extension and marketing activities among smallholder farmers in Sub Saharan Africa below in eight summary points. These build on the results presented in the report, but also our academic working papers to date (Maertens et al. 2019, Nourani et al. 2019 and Krah et al. 2019), and the review of the literature we conducted throughout the project.

(1) Make field-days fit for purpose: Farmers should be given tools which will allow them to learn the information presented more effectively. Examples might include pamphlets with pictures of the inputs used and measuring spoons to measure the correct amounts of inputs; these can "nudge" farmers trying out the presented technologies. We recommend pre-testing the effectiveness of these tools in a

pilot randomized controlled trial prior to using them. Farmers can be encouraged to learn by matching with participants to field-day locations, which are similar in terms of growing conditions.

(2) Sequence information delivery mechanisms: Field-days could be used in sequence with demonstration plots or other more intensive methods of teaching farmers. The field-days could serve to introduce a new technology and to focus on its broad features, principles, and processes and this initial introduction could be followed, a few weeks or at most a few months later, by methods employing more detailed exposure focussing on how to use the technology, perhaps based on farmer demand.

(3) Beware of learning traps: When on-site demonstration plots perform poorly, perhaps due to weather conditions or other external factors, farmers might attribute this to the new technology being introduced, resulting in a learning/non-adoption trap. In this study we have shown how the knowledge generated by demonstration plot farmers depends on the performance of the local demonstration plot. We recommend that each demonstration plot is followed by a group discussion led by an agronomist, jointly with the farmers analysing the yield and its contributing factors. We also recommend repeating demonstration plots over time, and setting them up in nearby but different locations.

(4) Pay attention to how you create farmer clubs: When farmer clubs are naturally formed, they might exclude the poorest or other minorities. Similarly, the wealthier, progressive farmers might also opt out, perhaps due to a high opportunity cost of time. A baseline census of demographic characteristics and estimated assets or other measures of poverty should allow one to get an overview of the households, while a network mapping exercise can shed light on existing information flows. Using these two sources of information, one can put restrictions on club formation, balancing the need to include the poorest with the need to include leaders (see Nourani et al. 2019; and Beaman et al. 2018).

(5) Reduce free-riding with farmer clubs: The success of the farmer clubs depends on the degree to which club members cooperate with each other, and do not free-ride on each others' efforts. Free-riding can be drastically reduced by encouraging the groups to adopt democratic methods and decision-making processes (see Nourani et al. 2019). Alternative methods may include changing the timeline, reward system or incentives (see among others Vasilaky and Islam for insights among female farmers in Uganda 2018).

(6) Combine extension with credit interventions: While we could not show the joint benefit of extension and marketing programs in this impact evaluation, we show in Maertens et al. (2019) that farmers' learning is constrained by credit markets. This suggests that agricultural extension might need a re-coupling with market activities, and in particular, credit interventions in order to be effective.

(7) The need for a credible, well-planned market intervention: In our study, the marketing intervention proved ineffective, largely due to the lack of uptake. We recommend that any marketing intervention is announced well before the growing seasons starts, is clearly communicated to farmers, and is implemented at the start of the sales season. We know that farmers can respond to changes in output markets (Allen and Atkin 2016), but if a practitioner wants to generate these changes, their program needs to be credible and predictable. It is however our view that the majority of the work on the marketing end needs to be

coordinated with the government given the fact that the market infrastructure, pricing interventions and market competitiveness are all aspects largely under control of the national government. We return to this matter in Section 9.3.

(8) Collect data: We would strongly recommend that any practitioner collects data both before and after the intervention takes place, ideally among both the participants of the program and a comparable set of participants. The current M&E practices tend to focus on collecting information on inputs, for instance, the number of attendees, rather than intermediate and final outcomes. In particular, there tends to be a lack of information on longer-term outcomes. We recommend expanding M&E to further inform interventions and policies and evaluate their effectives accurately. The next box includes six tips to strengthen current M&E practices.

SIX TIPS

(1) Exploit secondary data, for instance, the Demographic and Health Surveys and the Living Standards Measurement Surveys. These datasets can have information on household assets, household location (GPS), access to media, sanitation facilities and water sources, and also the adoption of agricultural technologies.
(2) Collect supplementary data from non-household sources, for instance, from agro-dealers, government and international research sources, on infrastructure, prices, price interventions, weather and climate and soils. One can also consider satellite data which can contain information on weather or yields on a larger scale (see Lobell et al. 2018 for a discussion and introduction).
(3) Pilot measures, and in this pilot pay particular attention to (i) How to include recall questions and questions with a time dimension (Beegle et al. 2012), (ii) how to approach subjective measures of beliefs, health and access (Grosh and Glewwe, 2000) (iii) whom the respondent should be.
(4) Consider using information technology (IT) to collect data; for instance, data on market prices and availability can be collected from market actors through a weekly phone call; data on daily household use can be collected from households through SMS messages (013).
(5) Ensure responsiveness: While refusal to participate in in-person surveys is rare in developing countries, refusal rates go up when one uses alternative methods. Consider rewarding respondents financially, a chance to win a substantial prize often does better than a small amount.
(6) Consider lab-in-the-field experiments: This is a cost-effective method of gathering evidence: one simulates a program using a realistic, but smaller-scale version of the program. One then invites 20-30 participants and divides these into a treatment and a control group. The treatment group receives the program, and the control does not. Differences between the two groups can shed light on what might work in “real life” (Levitt and List, 2009).

9.3 Lessons for policy

To derive lessons for policy, we reflect not only on our project, but on similar projects in the area. Our and others’ results have implications for governments of Malawi and other Sub-Saharan African countries working to reform extension systems, moving from traditional training and visit systems to systems which aim to be more demand-driven, accountable and cost-effective (for a discussion on the status of Malawi's extension system, see MEAS 2012 and MAIWD 2016). This change is the result of a combination of declining budgets for extension, partially due to a donor retreat from extension, and the perceived lack of effectiveness of traditional extension systems (see, for instance, Davis 2008, Evenson 1997, Anderson et al. 2006). The Malawian government's extension system is under significant strain, under-resourced and under-incentivised. Extension workers, generally equipped with a bicycle only, are expected to cover long distances and to conduct a range of government and non-government activities with minimal support (see Knorr et al. 2007).

Many institutions for training agricultural extension agents have closed and those remaining now require that students pay their own fees for a MS degree in extension. In turn, extension workers receive a comparatively small, monthly, fixed salary. This situation has reportedly led to pervasive problems with moral hazard and adverse selection. The type of student that can afford the requisite training might not be interested in returning to work in rural areas and ends up being employed by NGOs or other private institutions, draining the government extension system. The fixed salary might further reduce the uncontractable) effort of extension officers (MEAS 2012, CISANET 2013, MAIWD 2016).

Despite these challenges, government extension workers are still a main source of information for farmers. Ragasa and Niu (2017), in a comprehensive overview of access and demand for agricultural information, note that almost 70 percent of households who received advice from external sources received it from government extension agents.

The suggestions under Section 9.2 also apply to national governments. In addition, the government might consider changing the incentive structure of their extension agents. BenYishay and Mobarak (2013), show that incentivizing extension agents in Malawi by paying them for farmer knowledge improvements improves farmers' uptake of these technologies. Alternatively, one might increase the strength of the stick, as in Dal Bo et al. (2018) who show that tracking the extension workers via GPS (in Paraguay), especially when the ones to be tracked are chosen by the supervisors, might increase the effectiveness of extension services. Or simple changes like changing the sex of the extension agent might have an effect (as in Kondylis et al. 2016).

Combining extension services with credit services is also something that is better initiated by governments rather than local actors. Burgess and Pande (2005) show the far-reaching impacts on rural poverty that a reasonably well executed bank reform can have. In India, a state-led branch expansion program drastically increased the number of bank offices in rural areas, proving formal credit to farmers and other rural households. In the Malawian case, extension agents used to perform an additional role as regional credit officers. While conflicts of interest should be avoided, providing farmers access to credit while introducing a new intervention is likely to affect uptake and learning given evidence that credit access itself influences how open the farmer is to receiving information on capital-intensive technologies. Ambler et al. (2017), using a randomized control trial set in Malawi, also note complementarities between cash transfers and a more intensive (as opposed to extensive, standard) extension system.

Finally, we conclude with a note on infrastructure and pricing policies. It is well established in economics that infrastructure matters. Roads matter, railways matter and phone penetration matters. Our surveys indicated that the bulk of the tobacco farmers sell within the village; and 80% of soy farmers sell in the village or nearby town. This situation might result in local monopsonies, with local traders offering low prices to farmers. While formal evidence might be lacking in the context of Malawi (for a discussion see also Dillon and Dambro 2017), our qualitative interviews confirm this interpretation. The cost for farmers to transport produce to nearby markets is perceived to be too high for an individual farmer to take on. While improving roads might seem daunting, there is perhaps a simpler infrastructure that can be provided and which might improve market competition.

Cell phone penetration is currently not as high in Malawi as it is in other Sub-Saharan African countries. Improving this situation, combined with a structured access of farmers to market information (weekly prices, etc) through SMS messages might improve market competition (Aker and Fafchamps 2015). In addition, using cell phones as a medium might provide an appealing alternative to traditional extension methods (Aker 2011 and Davis 2008). But, given the complexity of Integrated Soil Fertility and Management Methods, SMS messages would need to use simple language, be growing-condition specific. SMS messages can also be utilised to repeat information, as in Dzanku et al. (2018), who reminded farmers of optimal storage practices at the time of harvest in Ghana.

The final aspect that deserves consideration is market pricing. While Malawi has minimum pricing for most crops, these prices are often not been adhered to by traders, and the government agencies are commonly not able to meet the farmers' supply, and perhaps as a response, only enter the market a few months after the harvest. For many farmers, this is too late, and by that time they would have sold their produce at a relatively low price (Barrett 2008, Bellemare and Barrett 2006 and Key et al. 2000). Understanding how farmers perceive prices and price volatility, and the responses in terms of market participation and crop and technology choices still requires more research. But we do know that these government policies matter, and can be set up taking into account the constraints of smallholder farmers.

Table 26: Descriptive statistics of villages, by demonstration plot and CDI club membership status, at baseline in 2014

	Demo plot villages			Non-demo plot villages			P-value
	N	Mean.	St. Dev	N	Mean.	St. Dev	
	(1)	(2)	(3)	(4)	(5)	(6)	
Distance to an all-weather/paved road (km)	17	1.95	2.57	39	1.87	(7)	0.9196
Distance to a national highway (km)	17	5.68	6.17	39	8.61	11.41	0.2216
Distance to a seasonal input market (km)	17	12.38	10.09	39	13.08	10.48	0.8149
Distance to an year-round input market (km)	17	5.48	4.99	38	5.79	6.84	0.8498
Distance to bank (km)	17	14.21	8.66	38	18.53	11.21	0.1273
Distance to seasonal output market (km)	16	7.13	10.12	39	3.75	3.60	0.2098
Distance to year-round output market (km)	17	3.47	4.45	39	2.45	2.54	0.3885
Number of households	17	50.82	31.21	38	59.08	41.50	0.4199
Number of individuals	16	330.69	191.24	36	379.08	388.94	0.5507
Percentage of women	16	57.61	8.07	32	60.81	8.51	0.2119
Size of the largest ethnic group (in percentage)	17	94.65	11.34	39	94.90	10.99	0.9394
Number of ethnic groups	17	1.29	0.69	39	1.13	0.47	0.3729
Area under soy cultivation (percentage)	17	26.94	20.98	39	23.38	14.23	0.53
Farmers cultivating soy (percentage)	17	53.24	26.45	39	42.21	28.16	0.1691
Number of visits by govt. extension agents (last year)	17	4.29	5.58	39	7.15	16.86	0.348
Number of visits by NGO extension agents (last year)	16	11.19	13.47	37	14.54	16.93	0.4479
Number of organisations active in the village	17	1.82	1.29	39	1.82	1.32	0.9937
Average number of members per organisation	17	12.28	16.40	39	12.70	10.14	0.9237
Daily wage rate at planting time	17	1284.00	1287.73	39	1664.85	1773.45	0.3722
Daily wage rate outside of peak times	17	811.76	484.62	39	1387.18	1999.70	0.0983
Daily wage rate at harvesting time	17	817.65	433.35	39	1246.15	1193.98	0.0548
Distance to EPA capital	17	16.38	4.88	39	15.05	6.08	0.3936
Total number of villages	17			39			

This table presents the descriptive statistics of the village questionnaire for all demonstration plot villages (Columns (1) through (3)) and the complementary set of non-demonstration plot villages (Columns (4) through (6)). Column (7) presents the P-value of a t-test with unequal variances between these two groups. The sample include all villages which were revisited at midline and belong to the treatment group, N=56. Similar results are obtained when one extends this set to the endline villages.

Online appendixes

Online appendix A: Field notes

https://www.3ieimpact.org/sites/default/files/2020-07/TW4.1018-Online-appendix-A-Field-notes.pdf

Online appendix B: Survey instruments

https://www.3ieimpact.org/sites/default/files/2020-07/TW4.1018-Online-appendix-B-Survey-instruments.pdf

Online appendix C: Pre-analysis plan

https://www.3ieimpact.org/sites/default/files/2020-07/TW4.1018-Online-appendix-C-Pre-analysis-plan.pdf

Online appendix D: Sample size and power calculations

https://www.3ieimpact.org/sites/default/files/2020-07/TW4.1018-Online-appendix-D-Sample-size-and-power-calculations.pdf

Online appendix E: Descriptive statistics at baseline

https://www.3ieimpact.org/sites/default/files/2020-07/TW4.1018-Online-appendix-E-Descriptive-statistics-at-baseline.pdf

References

Abadie, A. and G.W. Imbens. 2009. "Matching on the Estimated Propensity Score." NBER Working Paper No. 15301.

Adolwa, I. S., Schwarze, S., & Buerkert, A. (2019). “Impacts of integrated soil fertility management on yield and household income: The case of Tamale (Ghana) and Kakamega (Kenya).” *Ecological Economics*, *161*, pp. 186-192.

Aggarwal, S., E. Francis, and J. Robinson, “Grain Today, Gain Tomorrow: Evidence from a Storage Experiment with Savings Clubs in Kenya,” Working Paper, 2017.

AGRA and IIRC. 2014. Investing in soil: Cases and lessons from AGRA's Soil Health Programme. Alliance for a Green Revolution in Africa and International Institute of Rural Reconstruction, Nairobi.

Aker, J. C., & Fafchamps, M. (2015). *Mobile phone coverage and producer markets: Evidence from West Africa*. Oxford University Press on behalf of the World Bank. World Bank. License: CC BY-NC-ND 3.0 IGO.

Akinnifesi, F.K., W. Makumba, G. Sileshi, O. C. Ajayi, D. Mweta. 2007. “Synergistic Effect of Inorganic N and P Fertilizers and Organic Inputs from Gliricidia sepium on Productivity of Intercropped Maize in Southern Malawi.” Plant and Soil. 294 (1-2), p. 203-217.

Ambler, K., de Brauw, A. and S. Godlonton. 2017. "Relaxing Constraints for Family Farmers: Providing Capital and Information in Malawi." Working Paper Presented at NEUDC 2017 at Tufst University.

Anderson, J.R. and Feder, G., 2007. "Agricultural Extension." in: Handbook of Agricultural Economics, 3, pp.2343-2378.

Anderson, J.R.,Feder, G. and Ganguly, S. 2006. "The rise and fall of Training and Visit extension: An Asia mini-drama with an African Epilogue," in A.W. Van den Ban and R.K Samantha (eds.) Changing Role of Agricultural Extension in Asian nations. new Delhi: B.R Publishing Corporation, pp. 149-74.

Bardasi, E., Beegle, K., Dillon, A. and P. Serneels. 2011. “Do Labour Statistics Depend on How and to Whom the Questions Are Asked? Results from a Survey Experiment in Tanzania.” *World Bank Economic Review,* 25(3): 418-47.

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from eastern and southern Africa. *Food policy*, *33*(4), 299-317.

Beaman, L., BenYishay, A., Magruder, J., and A.M. Mobarak. 2018. "Can Network Theory-based Targeting Increase Technology Adoption?" NBER Working Paper No. 24912.

Beegle. K., Carletto, C., and K. Himelein. 2012.”Reliability of Recall Data in Agricultural Data.” *Journal of Development Economics*, 98(1), 31-41.

BenYishay, A. and M. Mobarak, 2018. “Social Learning and Incentives for Experimentation and Communication.” *Review of Economic Studies,* 86(3), pp. 976-1009.

BenYishay, A. and Mobarak, A.M., 2013. "Communicating with Farmers through Social Networks." Working Paper.

Bevis, L.E., and C.B. Barrett, C.B. 2016. "Close to the Edge: Do Behavioral Explanations Account for the Inverse Productivity Relationship? Working Paper.

Bezu, S., Kassie, G.T., Shiferaw, B. and Ricker-Gilbert, J., 2014. "Impact of Improved Maize Adoption on Welfare of Farm Households in Malawi: A Panel Data Analysis." World Development, 59, pp.120-131.

Birkhaeuser, D., Evenson, R.E. and Feder, G., 1991. "The Economic Impact of Agricultural Extension: A Review." Economic Development and Cultural Change, 39(3), pp.607-650.

Birner, R., Davis, K., Pender, J., Nkonya, E., Anandajayasekeram, P., Ekboir, J., Mbabu, A., Spielman, D., Horna, D., Benin, S. and Cohen, M., 2009 "From Best Practice to Best Fit: A Framework for Designing and Analyzing Pluralistic Agricultural Advisory Services Worldwide." The Journal of Agricultural Education and Extension 15(4): 341-355.

Burke, M, L. Bergquist, and E. Miguel “Sell Low and Buy High: An Arbitrage Puzzle” Quarterly Journal of Economics, vol.134, no. 2, 785–842, May 2019

Cameron, A.C., and D.L. Miller. 2015. “A Practitioner’s Guide to Cluster-Robust Inference.” Journal of Human Resources, 50(2): 317-372.

Chirwa, E. and Dorward, A. 2013. Agricultural Input Subsidies: The Recent Malawi Experience, Oxford: Oxford University Press.

Chivenge, P., Vanlauwe, B., & Six, J. (2011). Does the combined application of organic and mineral nutrient sources influence maize productivity? A meta-analysis. *Plant and Soil*, *342*(1-2), 1-30.

CISANET (Civil Society Agricultural Network). 2013. The State of Agricultural Extension Services in Malawi. Available from: http://www.cisanetmw.org/index.php/publications

Chuang, Y., & Schechter, L. 2015. “Stability of experimental and survey measures of risk, time, and social preferences: A review and some new results.” *Journal of Development Economics*, *117*, pp. 151-170.

Conley, T.G. and Udry, C.R., 2010. "Learning about a New Technology: Pineapple in Ghana." The American Economic Review, 100(1), pp.35-69.

Dal Bo, E., F. Finan, N. Y., Li and L. Schechter. 2018. "Government Decentralization Under Changing State Capacity: Experimental Evidence from Paraguay." Working Paper.

Dillon, B and C. Dambro. 2017. “How Competitive are Crop Markets in Sub-Saharan Africa.” American Journal of Agricultural Economics, 99(5), pp. 1344-1361.

Dorward, Andrew, and Ephraim Chirwa. 2011 "The Malawi agricultural input subsidy programme: 2005/06 to 2008/09." *International journal of agricultural sustainability* 9.1, pp. 232-247.

Duflo, E., Kremer, M. and Robinson, J., 2008. "How High are Rates of Return to Fertilizer? Evidence from Field Experiments in Kenya." The American Economic Review, 98(2), pp.482-488.

Dzanku, F. M, Osei, R. D, Osei-Akoto, I., Hodley, L. S., Adu, P.N. and K. Adu-Ababio. 2018. "Do Mobile Phone Voice Messages Reminders Following Face-to-Face Training Improve Adoption and Smallholder Farmer Outcomes." Presented at CSAE 2018.

Evenson, R., 1997. "The Economic Contributions of Agricultural Extension to Agricultural and Rural Development." In: Improving Agricultural Extension. A Reference Manual. Swanson, B.E. (ed.) Bentz, R.P. (ed.) Sofranko, A.J. (ed.) / FAO, Rome (Italy). Research, Extension and Training Div. , p. 27-36.

Fairhurst, T. 2012. Handbook for Integrated Soil Fertility Management. Africa Soil Health Consortium.

Feder, G.,Willet, A., and Zijp,W., 1999. "Agricultural Extension: Generic Challenges and some Ingredients for Solutions." World Bank Policy Research Working Paper 2129, World Bank, Washington, DC.

Foster, A.D. and Rosenzweig, M.R., 1995. "Learning by Doing and Learning from Others: Human Capital and Technical Change in Agriculture." Journal of political Economy, 103(6), pp.1176-1209.

Franke, A.C., Van Den Brand, G.J. and Giller, K.E., 2014. "Which Farmers Benefit Most from Sustainable Intensification? An ex-ante Impact Assessment of Expanding Grain Legume Production in Malawi." European Journal of Agronomy, 58, pp.28-38.

Glennester, R. and K. Takavarasha. 2013. Running Randomized Evaluations, A practical Guide. Princeton University Press.

GOM (Government of Malawi) 2010. The Agriculture Sector Wide Approach (ASWAp): Malawi's Prioritized and Harmonized Agricultural Development Agenda, Lilongwe: Ministry of Agriculture and Food Security.

Harrigan, Jane. *From dictatorship to democracy: economic policy in Malawi 1964-2000*. Routledge, 2018.

Independent Evaluation Group (IEG). 2011. Impact Evaluations in Agriculture: An Assessment of the Evidence. Washington, DC: World Bank.

Kanyama-Phiri, S. Snapp, B. Kamanga and K. Wellard. 2000. Towards Integrated Soil Fertility Management in Malawi: Incorporating Participatory Approaches in Agricultural Research. Managing Africa's Soils No. 11. ICRISAT Publication.

Kerr, R.B., Snapp, S., Chirwa, M., Shumba, L. and Msachi, R., 2007. "Participatory Research on Legume Diversification with Malawian Smallholder Farmers for Improved Human Nutrition and Soil Fertility." Experimental Agriculture, 43(04), pp.437-453.

Kondylis, F. , Mueller, V., Sheriff, G. and S. Zhu. 2016. "Do Female Instructors Reduce Gender Bias in Diffusion of Sustainable Land Management Techniques? Experimental Evidence From Mozambique." *World Development,* 78, pp. 436–449.

Kondylis, F., Mueller, V. and J. Zhu, 2017 "Seeing is believing? Evidence from an extension network experiment," Journal of Development Economics, 125, pp. 1.20.

Krueger, R.A., and M. A. Casey. 2008. Focus Groups: A Practical Guide for Applied Research. 4th ed. SAGE Publications, Inc.

Lobell, D.B., Azzari, G., Burke, M., Gourlay, S., Zhenong, J., Kilic, T.; Murray, S. 2018. “Eyes in the Sky, Boots on the Ground: Assessing Satellite- and Ground-Based Approaches to Crop Yield Measurement and Analysis in Uganda.” Policy Research Working Paper, No. WPS 8374. Washington, D.C.: World Bank Group.

Lunduka, R.W., Snapp, S., and T.S. Jayne. 2018."Demand-Led and Supply-Led Extension Approaches to Support Sustainable Intensification in Malawi." Working Paper.

Maertens, A., 2017. "Who Cares what Others Think (or do)? Social Learning and Social Pressures in Cotton Farming in India." American Journal of Agricultural Economics.

Maertens, A.; Michelson, H. and V. Nourani. 2019. “How do Farmers Learn from Extension Services? Evidence from Malawi.” Working Paper.

Mafongoya P.L., A. Bationo, J. Kihara and B.S. Waswa. 2006. Appropriate Technologies

MAIFS (Ministry of Agriculture, Irrigation and Food Security), Govt. of Malawi. 2012. Guide to Agriculture Production and Natural Resource Management in Malawi.

MAIWD (Ministry of Agriculture, Irrigation and Water Development), Govt. of Malawi. 2016. National Agricultural Policy.

Malawi Vulnerability Assessment Committee (MVAC) (2005) Malawi Baseline Livelihood Profiles Version 1, Lilongwe: Malawi Vulnerability Assessment Committee

Management Options for Malawi: Can Smallholder Farmers Grow more Legumes? Agriculture, Ecosystems and Environment 91: 159-174

Manda, J., Alene, A.D., Gardebroek, C., Kassie, M. and Tembo, G., 2016. "Adoption and Impacts of Sustainable Agricultural Practices on Maize Yields and Incomes: Evidence from Rural Zambia." Journal of Agricultural Economics, 67(1), pp.130-153.

Marenya, P.P. and C.B. Barrett. 2007. "Household-Level Determinants of Adoption of Improved Natural Resources Management Practices among Smallholder Farmers in Western Kenya," Food Policy, 32(4), pp. 536.

MEAS (Modernizing Extension and Advisory Services). 2012. "Strenthening Pluralistic Agricultural Extension in Malawi." Report on the MEAS Rapid Scoping Mission carried out January 7-27, 2012.

Mhango W.G., S.S. Snapp and G.Y. Kanyama-Phiri. 2012. Opportunities and Constraints to Legume Diversification for Sustainable Maize Production on Smallholder Farms in Malawi. Renewable Agriculture and Food Systems: 28: 234-244.

Minot, N., Kherallah, M., P. Berry. 2000. Fertilizer, Market Reform and the Determinants of Fertilizer Use in Benin and Malawi. MSSD Discussion Paper No. 40. International Food Policy Research Institute.

Morgan, D.L. 1996. “Focus Groups.” Annual Review of Sociology 22: 129–52.

Mugwe, J., Mugendi, D., Mucheru-Muna, M., Merckx, R., Chianu, J. and B. Vanlauwe. 2009. "Determinants of the Decision to Adopt Integrated Soil Fertility Management Practices by Smallholder Farmers in the central Highlands of Kenya." Experimental Agriculture, 45(1), pp. 61-75.

National Statistical Office (NSO) (2012) Integrated Household Survey 2011 - 2012: Household Socio-economic Characteristics Report, Zomba: National Statistical Office.

National Statistical Office (NSO) (2017) Integrated Household Survey 2016 - 2017: Household Socio-economic Characteristics Report, Zomba: National Statistical Office.

National Statistical Office (NSO) (2018) 2018 Malawi Population and Housing Census: Preliminary Report, Zomba: National Statistical Office.

National Statistical Office (NSO) and World Bank (2018) Methodology for Poverty Measurement in Malawi (2016/17), Zomba: National Statistical Office

Niu, C. and C. Ragasa. 2017. "Limited attention and information loss in the lab-to-farm knowledge chain: The case of Malawian agricultural extension programs." IFPRI discussion paper, pp. 56.

Njoloma, J.P., Sileshi, W.G., Sosola, B.G., Nalivata, P.C. and Nyoka, B.I., 2016. "Soil Fertility Status Under Smallholder Farmers Fields in Malawi." African Journal of Agricultural Research, 11(19), pp.1679-1687.

Nkonya E., Johnson, T., Kwon, H._. and E. Kato. 2016. "Economics of Land Degradation in Sub-Saharan Africa," In: E. Nkonya, A. Mirzabaev and J. von Braun (eds). *Economics of Land Degradation and Improvement . A Global Assessment for Sustainable Development.* Springer, pp. 215-260.

Nkonya, E., Azzari, C., Kato, E., Koo, J., Nziguheba, G. and B. _anlauwe. 2017. *Mapping Adoption of ISFM Practices Study: The Case of Keny,a Rwanda and Zambia.* IFPRI AND IITA Report.

Nourani, C., Maertens, A. and Michelson, H. 2019. “Public Good Provision and Deliberative Democracy: Evidence from Malawi.” Working Paper.

Pauw, K, J. Thurlow and D. Van Seventer. 2010. “Droughts and Floods in Malawi: Assesing the Economywide Effects.” IFPRI Discussion Report.

Picclotto, R. and J.R. Anderson, 1997. "Reconsidering Agricultural Extension." World Bank Research Observer, 12(2), pp. 249-59.

Place, F., Barrett, C,B, Freeman, H.A, Ramisch, J.J. and B. Vanlauwe, 2003. "Prospects for Integrated Soil Fertility Management using Organic and Inorganic Inputs: Evidence from Smallholder African Agricultural Systems." Food Policy, 28(4), pp. 365-378.

Ragasa, C. and C. Niu. 2017. The state of agricultural extension and advisory services provision in Malawi: Insights from household and community surveys. Report International Food Policy Research Institute (IFPRI).

Ragasa, C. and J. Mazunda. 2018. "The Impact of Agricultural Extension Services in the Context of a Heavily Subsidized Input System: The Case of Malawi," World Development, 105, pp. 25-47.

Sanchez, P.A. 2002. "Soil Fertility and Hunger in Africa." Science, 295 (5562), pp. 2019-2020.

Sauer, J. and Tchale, H., 2009. "The Economics of Soil Fertility Management in Malawi." Review of Agricultural Economics, 31(3), pp.535-560.

Sheahan, M., and C. B. Barrett,2017. "Ten Striking Facts about Agricultural Input Use in Sub-Saharan Africa." Food Policy, 67, pp. 12-25.

Snapp, S. S., Rohrbach, D. D., Simtowe, F., & Freeman, H. A. (2002). Sustainable soil management options for Malawi: can smallholder farmers grow more legumes?. *Agriculture, ecosystems & environment*, *91*(1-3), 159-174.

Snapp, S.S. 1998. "Soil nutrient status of smallholder farms in Malawi." Communication in Soil and Plant Analysis 29 (17&18),pp. 2571-2588.

Stephens, E.C. and C.B. Barrett, “Incomplete credit markets and commodity marketing behaviour,” Journal of Agricultural Economics, 2011, 62 (1), 1–24.

Tully, K., Sullivan, C., Weil, R. and Sanchez, P., 2015. "The State of Soil Degradation in Sub-Saharan Africa: Baselines, Trajectories, and Solutions." Sustainability, 7(6), pp.6523-6552.

Vanlauwe, B. and K.E. Giller, 2006. "Popular Myths around Soil Fertility Management in Sub-Saharan Africa." Agriculture, Ecosystems and the Environment, 116, pp 34--46.

Vasilaky, K. and K.Leonard, 2017. “As Good as the Networks they Keep?: Improving Outcomes through Weak Ties in Rural Uganda.” *Economic Development and Cultural Change*, 66(4), pp. 755-792.

Vasilaky, K., and A.M. Islam, 2018. “Competition or Cooperation? Using Team and Tournament Incentives for Learning Among Female Farmers in Rural Uganda” *World Development,* 103, pp. 216-225

Waddington, H. and H. White. 2014. Farmer Field Schools: From Africultural Extension to Adult Education. 3IE Systematic Review Summary.

Wooldridge, J. 2013. Introductory Econometrics: A Modern Approach. South-Western College Publishing.

Wossen, T., Berger, T. and Di Falco, S., 2015. "Social Capital, Risk Preference and Adoption of Improved Farm Land Management Practices in Ethiopia." Agricultural Economics, 46(1), pp.81-97.

Other publications in the 3ie Impact Evaluation Report Series

The following reports are available from http://3ieimpact.org/evidence-hub/publications/impact-evaluations

Impacts of linking savings group to formal financial service providers and strengthening their internal group insurance mechanism in Zambia, 3ie Impact Evaluation Report 121. Frölich, M and Nguyen, PL, 2020.

Promoting latrine use in rural Karnataka using the risks, attitudes, norms, abilities and self-regulation (RANAS) approach, 3ie Impact Evaluation Report 120. Friedrich, M, Balasundaram, T, Muralidharan, A, Raman, VR and Mosler, H-J, 2020.

Impacts of low-cost interventions to improve latrine use and safe disposal of child faeces in rural Odisha, India, 3ie Impact Evaluation Report 119. Caruso, BA, Sclar, GD, Routray, P, Nagel C, Majorin, F, Sola, S, Koehne, W, DeShay, R, Udaipuria, S, Williams, R and Clasen, T, 2020.

Improving households' attitudes and behaviours to increase toilet use (HABIT) in Bihar, India, 3ie Impact Evaluation Report 118. Viswanathan, S, Saith, R, Chakraborty, A, Purty, N, Malhotra, N, Singh, P, Mitra, P, Padmanabhan, V, Datta, S, Harris, J, Gidwani, S, Williams, R, Florence, E and Daniel, S, 2020.

Rebuilding the social compact: urban service delivery and property taxes in Pakistan, 3ie Impact Evaluation Report 117. Khwaja, AI, Haq, O, Khan, AQ, Olken, B and Shaukat, M, 2020.

Rural institutional innovation: can village courts in Bangladesh accelerate access to justice and improve socio-economic outcomes? 3ie Impact Evaluation Report 116. Mattsson, M and Mobarak, AM, 2020.

Using big data to evaluate the impacts of transportation infrastructure investment: the case of subway systems in Beijing, 3ie Impact Evaluation Report 115. Li, S and Liu, Y, 2020.

Community toilet use in Indian slums: willingness-to-pay and the role of informational and supply side constraints, 3ie Impact Evaluation Report 113. Armand, A, Augsburg, B, Bancalari A and Trivedi B, 2020.

Impacts, maintenance and sustainability of irrigation in Rwanda, 3ie Impact Evaluation Report 112. Byiringo, E, Jones M, Kondylis F, Loeser J, Magruder, J and Ndahimana, C, 2020.

Continuous Emissions Monitoring Systems (CEMS) in India, 3ie Impact Evaluation Report 111. Greenstone, M, Pande, R, Ryan, N and Sudarshan A, 2020.

Evaluating the impacts of the Dar es Salaam Bus Rapid Transit System, 3ie Impact Evaluation Report 110. Morten, M, Bryan, G, Siddiqi, B, Balboni, C, 2020.

Access to safe drinking water: experimental evidence from new water sources in Bangladesh, 3ie Impact Evaluation Report 109. Cocciolo, S, Ghisolfi, S, Habib, A, Rashid, SMA and Tompsett, A, 2020.

Impact of alternate wetting and drying on farm incomes and water savings in Bangladesh, 3ie Impact Evaluation Report 108. Chakravorty, U, Dar, MH, Emerick, K, 2020.

The effects of vouchers for essential household items on child health, mental health, resilience and social cohesion among internally displaced persons in the Democratic Republic of Congo, 3ie Impact Evaluation Report 107. Quattrochi, J, Bisimwa, G, Thompson, T, van der Windt, P and Voors, M, 2020.

Measuring impacts of conservation interventions on human well-being and the environment in Northern Cambodia, 3ie Impact Evaluation Report 106. Clements, T, Neang, M, Milner-Gulland, EJ and Travers, H, 2020.

The 5 Star Toilet Campaign: improving toilet use in rural Gujarat, 3ie Impact Evaluation Report 105. Chauhan, K, Schmidt, WP, Aunger, R, Gopalan, B, Saxena, D, Yashobant, S, Patwardhan, V, Bhavsar, P, Mavalankar, D and Curtis, V, 2020.

How education about maternal health risk can change the gender gap in the demand for family planning in Zambia, 3ie Impact Evaluation Report 104. Ashraf, N, Field, E, Voena, A and Ziparo, R, 2019.

In search of the holy grail: can unconditional cash transfers graduate households out of poverty in Zambia?, Impact Evaluation Report 103. Handa, S, Tembo, G, Natali, L, Angeles, G and Spektor, G, 2019.

Increasing HIV self-testing and linkage to care for partners of women in antenatal care in Uganda, Impact Evaluation Report 102. Wanyenze, R, Buregyeya, E, Matovu, J, Kisa, R, Kagaayi, J, Vrana-Diaz, C, Malek, A, Musoke, W, Chemusto, H, Mukama, S and Korte, J, 2019.

Improving the quality of care for children with acute malnutrition in Uganda, 3ie Impact Evaluation Report 101. Marzia, L, Wanzira, H, Lochoro, P and Putoto, G, 2019.

Impacts of increasing community resilience through humanitarian aid in Pakistan, 3ie Impact Evaluation Report 100. Avdeenko, A and Frölich, M, 2019.

Impacts of community monitoring of socio-environmental liabilities in the Ecuadorian and Peruvian Amazon, 3ie Impact Evaluation Report 99. Pellegrini, L, 2019.

Increasing HIV testing demand among Kenyan truck drivers and female sex workers, 3ie Impact Evaluation Report 98. Kelvin, E, George, G, Mwai, E, Kinyanjui, S, Inoti, S, Chetty, T, Strauss, M, Romo, M, Oruko, F, Odhiambo J, Nyaga, E, Mantell, J and Govender, K, 2019.

Impacts of community stakeholder engagement interventions in Ugandan oil extractives, 3ie Impact Evaluation Report 97. Parker, R, Coleman, E, Manyindo, J, Schultz, B and Mukuru, E, 2019.

The impacts of formal registration of businesses in Malawi, 3ie Impact Evaluation Report 96. Campos, F, Goldstein, M and McKenzie, D, 2019.

Unpacking the determinants of entrepreneurship development and economic empowerment for women in Kenya, 3ie Impact Evaluation Report 95. McKenzie, D, Puerto, S and Odhiambo, F, 2019.

Impacts of key provisions in Ghana's Petroleum Revenue Management Act, 3ie Impact Evaluation Report 94. Edjekumhene, I, Voors, M, Lujala, P, Brunnschweiler, C, Owusu, CK and Nyamekye, A, 2019.

Using information to break the political resource curse in natural gas management in Mozambique, 3ie Impact Evaluation Report 93. Armand, A, Costa, AI, Coutts, A, Vicente, P and Vilela, I, 2019.

Harnessing transparency initiatives to improve India's environmental clearance process for the mineral mining sector, 3ie Impact Evaluation Report 92. Pande, R and Sudarshan, A, 2019.

Impacts of removing user fees for maternal health services on universal health coverage in Kenya, 3ie Impact Evaluation Report 91. Abuya, T, Dennis, M, Matanda, D, Obare, F and Bellows, B, 2018.

Impact of voice reminders to reinforce harvest aggregation services training for farmers in Mali, 3ie Impact Evaluation Report 90. Osei, RD, Dzanku, FM, Osei-Akoto, I, Asante, F, Hodey, LS, Adu, PN, Adu-Ababio, K and Coulibaly, M, 2018.

Impacts of Breakthrough's school-based gender attitude change programme in Haryana, India, 3ie Impact Evaluation Report 89. Jayachandran, S, Jain, T and Dhar, D, 2018.

Hotspot interventions at scale: the effects of policing and city services on crime in Bogotá, Colombia, 3ie Impact Evaluation Report 88. Blattman, C, Green, D, Ortega, D and Tobón, S, 2018.

Impact evaluation of the Philippine Special Program for Employment of Students, 3ie Impact Evaluation Report 87. Beam, E, Linden, L, Quimbo, S and Richmond, H, 2018.

Community-based distribution of oral HIV self-testing kits: experimental evidence from Zambia, 3ie Impact Evaluation Report 86. Hensen, B, Ayles, H, Mulubwa, C, Floyd, S, Schaap, A, Chiti, B, Phiri, M, Mwenge, L, Simwinga, M, Fidler S, Hayes, R, Bond, V and Mwinga, A, 2018.

Evaluating the economic impacts of rural banking: experimental evidence from southern India, 3ie Impact Evaluation Report 85. Field, E and Pande, R, 2018.

Direct provision versus facility collection of HIV tests: impacts of self-testing among female sex workers in Uganda. 3ie Impact Evaluation Report 84. Ortblad, K, Musoke, DK, Ngabirano, T, Oldenburg, C and Bärnighausen, T, 2018.

Increasing female sex worker HIV testing: effects of peer educators and HIV self-tests in Zambia, 3ie Impact Evaluation Report 83. Chanda, MM, Ortblad, KF, Mwale, M, Chongo, S, Kanchele, C, Kamungoma, N, Fullem, A, Bärnighausen, T and Oldenburg, CE, 2018.

Community delivery of antiretroviral drugs: a non-inferiority matched-pair pragmatic cluster-randomized trial in Dar es Salaam, Tanzania, 3ie Impact Evaluation Report 82. Francis, JM, Geldsetzer, P, Asmus, G, Ulenga, N, Ambikapathi, R, Sando, D, Fawzi, W and Bärnighausen, T, 2018.

Nourishing the future: targeting infants and their caregivers to reduce undernutrition in rural China, 3ie Impact Evaluation Report 81. Cai, J, Luo, R, Li, H, Lien, J, Medina, A, Zhou, H and Zhang, L, 2018.

Impacts of the World Food Programme’s interventions to treat malnutrition in Niger. 3ie Impact Evaluation Report 80. Brück, T, Ferguson, NTN, Ouédraogo, J and Ziegelhöfer, Z, 2018.

Impact evaluation of the World Food Programme’s moderate acute malnutrition treatment and prevention programmes in Sudan. 3ie Impact Evaluation Report 79. Guevarra, E, Mandalazi, E, Balegamire, S, Albrektsen, K, Sadler, K, Abdelsalam, K, Urrea, G and Alawad, S, 2018.

Impact evaluation of WFP’s programs targeting moderate acute malnutrition in humanitarian situations in Chad. 3ie Impact Evaluation Report 78. Saboya, M, Rudiger, J, Frize, J, Ruegenberg, D, Rodríguez Seco, A and McMillon, C, 2018.

Improving midday meal delivery and encouraging micronutrient fortification among children in India, 3ie Impact Evaluation Report 77. Shastry, GK, Berry, J, Mukherjee, P, Mehta, S and Ruebeck, H, 2018.

Evaluation of infant development centres: an early years intervention in Colombia, 3ie Impact Evaluation Report 76. Andrew, A, Attanasio, O, Bernal, R, Cordona, L, Krutikova, S, Heredia, DM, Medina, C, Peña, X, Rubio-Codina, M and Vera-Hernandez, M, 2018.

Can the wounds of war be healed? Experimental evidence on reconciliation in Sierra Leone. 3ie Impact Evaluation Report 75. Cilliers, J, Dube, O and Siddiqi, B, 2018.

Impact evaluation of the Menabe and Melaky development programme in Madagascar, 3ie Impact Evaluation Report 74. Ring, H, Morey, M, Kavanagh, E, Kamto, K, McCarthy, N, Brubaker, J and Rakotondrafara, C, 2018.

Impact evaluation of the Smallholder Dairy Commercialization Programme in Kenya, 3ie Impact Evaluation Report 73. Bonilla, J, McCarthy, N, Mugatha, S, Rai, N, Coombes, A and Brubaker, J, 2018.

Impact and adoption of risk-reducing drought-tolerant rice in India, 3ie Impact Evaluation Report 72. Yamano, T, Dar, MH, Panda, A, Gupta, I, Malabayabas, ML and Kelly, E, 2018.

Poverty and empowerment impacts of the Bihar Rural Livelihoods Project in India, 3ie Impact Evaluation Report 71. Hoffmann, V, Rao, V, Datta, U, Sanyal, P, Surendra, V and Majumdar, S 2018.

How should Tanzania use its natural gas? Citizens' views from a nationwide Deliberative Poll, 3ie Impact Evaluation Report 70. Birdsall, N, Fishkin, J, Haqqi, F, Kinyondo, A, Moyo, M, Richmond, J and Sandefur, J, 2018.

Impact evaluation of the conditional cash transfer program for secondary school attendance in Macedonia, 3ie Impact Evaluation Report 69. Armand, A and Carneiro, P, 2018.

Age at marriage, women's education, and mother and child outcomes in Bangladesh, 3ie Impact Evaluation Report 68. Field, E, Glennerster, R, Nazneen, S, Pimkina, S, Sen, I and Buchmann, N, 2018.

Evaluating agricultural information dissemination in western Kenya, 3ie Impact Evaluation Report 67. Fabregas, R, Kremer, M, Robinson, J and Schilbach, F, 2017.

General equilibrium impact assessment of the Productive Safety Net Program in Ethiopia, 3ie Impact Evaluation Report 66. Filipski, M, Taylor, JE, Abegaz, GA, Ferede, T, Taffesse, AS and Diao, X, 2017.

Impact of the Uddeepan programme on child health and nutrition in India, 3ie Impact Evaluation Report 65. Kochar, A, Sharma, A and Sharma, A, 2017.

Evaluating oral HIV self-testing to increase HIV testing uptake among truck drivers in Kenya, 3ie Impact Evaluation Report 64. Kelvin, EA, Mwai, E, Romo, ML, George, G, Govender, K, Mantell, JE, Strauss, M, Nyaga, EN and Odhiambo, JO, 2017.

Integration of EPI and paediatric HIV services for improved ART initiation in Zimbabwe, 3ie Impact Evaluation Report 63. Prescott, M, Boeke, C, Gotora, T, Mafaune, HW, Motsi, W, Graves, J, Mangwiro, A and McCarthy, E, 2017.

Increasing male partner HIV testing using self-test kits in Kenya, 3ie Impact Evaluation Report 62. Gichangi, A, Korte, JE, Wambua, J, Vrana, C and Stevens, D, 2017.

Evaluating the impact of community health worker integration into prevention of mother-to-child transmission of HIV services in Tanzania, 3ie Impact Evaluation Report 61. Nance, N, McCoy, S, Ngilangwa, D, Masanja, J, Njau, P and Noronha, R, 2017.

Using HIV self-testing to promote male partner and couples testing in Kenya, 3ie Impact Evaluation Report 60. Thirumurthy, H, Omanga, E, Obonyo, B, Masters, S and Agot, K, 2017.

Increasing male partner HIV self-testing at antenatal care clinics in Kenya, 3ie Impact Evaluation Report 59. Gichangi, A, Korte, JE, Wambua, J, Vrana, C and Stevens, D, 2017.

Impact of free availability of public childcare on labour supply and child development in Brazil, 3ie Impact Evaluation Report 58. Attanasio, O, Paes de Barros, R, Carneiro, P, Evans, D, Lima, L, Olinto, P and Schady, N, 2017.

Estimating the effects of a low-cost early stimulation and parenting education programme in Mexico, 3ie Impact Evaluation Report 57. Cardenas, S, Evans, D and Holland, P, 2017.

The Better Obstetrics in Rural Nigeria study: an impact evaluation of the Nigerian Midwives Service Scheme, 3ie Impact Evaluation Report 56. Okeke, E, Glick, P, Abubakar, IS, Chari, AV, Pitchforth, E, Exley, J, Bashir, U, Setodji, C, Gu, K and Onwujekwe, O, 2017.

*The Productive Safety Net Programme in Ethiopia: impacts on children's schooling, labour and nutritional statu*s, 3ie Impact Evaluation Report 55. Berhane, G, Hoddinott, J, Kumar, N and Margolies, A, 2016.

The impact of youth skills training on the financial behaviour, employability and educational choice in Morocco, 3ie Impact Evaluation Report 54. Bausch, J, Dyer, P, Gardiner, D, Kluve, J and Mizrokhi, E, 2016.

Using advertisements to create demand for voluntary medical male circumcision in South Africa, 3ie Impact Evaluation Report 53. Frade, S, Friedman, W, Rech, D and Wilson, N, 2016.

The use of peer referral incentives to increase demand for voluntary medical male circumcision in Zambia, 3ie Impact Evaluation Report 52. Zanolini, A, Bolton, C, Lyabola, LL, Phiri, G, Samona, A, Kaonga, A and Harsha Thirumurthy, H, 2016.

Using smartphone raffles to increase demand for voluntary medical male circumcision in Tanzania, 3ie Impact Evaluation Report 51. Mahler, H and Bazant, E, 2016.

Voluntary medical male circumcision uptake through soccer in Zimbabwe, 3ie Impact Evaluation Report 50. DeCelles, J, Kaufman, Z, Bhauti, K, Hershow, R, Weiss, H, Chaibva, C, Moyo, N, Braunschweig, E, Mantula, F, Hatzold, K and Ross, D, 2016.

Measuring the impact of SMS-based interventions on uptake of voluntary medical male circumcision in Zambia, 3ie Impact Evaluation Report 49. Leiby, K, Connor, A, Tsague, L, Sapele, C, Koanga, A, Kakaire, J and Wang, P, 2016.

Assessing the impact of delivering messages through intimate partners to create demand for voluntary medical male circumcision in Uganda, 3ie Impact Evaluation Report 48. Semeere, AS, Bbaale, DS, Castelnuovo, B, Kiragga, A, Kigozi, J, Muganzi, A, Kambugu, A and Coutinho, AG, 2016.

Optimising the use of economic interventions to increase demand for voluntary medical male circumcision in Kenya, 3ie Impact Evaluation Report 47. Thirumurthy, H, Omanga, E, Rao, SO, Murray, K, Masters, S and Agot, K, 2016.

The impact of earned and windfall cash transfers on livelihoods and conservation in Sierra Leone, 3ie Impact Evaluation Report 46. Bulte, E, Conteh, B, Kontoleon, A, List, J, Mokuwa, E, Richards, P, Turley, T and Voors, M, 2016.

Property tax experiment in Pakistan: Incentivising tax collection and improving performance, 3ie Impact Evaluation Report 45. Khan, A, Khwaja, A and Olken, B, 2016.

Impact of mobile message reminders on tuberculosis treatment outcomes in Pakistan, 3ie Impact Evaluation Report 44. Mohammed, S, Glennerster, R and Khan, A, 2016.

Making networks work for policy: Evidence from agricultural technology adoption in Malawi, 3ie Impact Evaluation Report 43. Beaman, L, BenYishay, A, Fatch, P, Magruder, J and Mobarak, AM, 2016.

Estimating the impact and cost-effectiveness of expanding access to secondary education in Ghana, 3ie Impact Evaluation Report 42. Dupas, P, Duflo, E and Kremer, M, 2016.

*Evaluating the effectiveness of computers as tutors in China, 3*ie Impact Evaluation Report 41. Mo, D, Bai, Y, Boswell, M and Rozelle, S, 2016.

Micro entrepreneurship support programme in Chile, 3ie Impact Evaluation Report 40. Martínez, CA, Puentes, EE and Ruiz-Tagle, JV, 2016.

Thirty-five years later: evaluating the impacts of a child health and family planning programme in Bangladesh, 3ie Impact Evaluation Report 39. Barham, T, Kuhn, R, Menken, J and Razzaque, A, 2016.

Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection and malnutrition in India, 3ie Impact Evaluation Report 38. Clasen, T, Boisson, S, Routray, P, Torondel, B, Bell, M, Cumming, O, Ensink, J, Freeman, M and Jenkins, M, 2016.

Evaluating the impact of vocational education vouchers on out-of-school youth in Kenya, 3ie Impact Evaluation Report 37. Hicks, JH, Kremer, M, Mbiti, I and Miguel, E, 2016.

Removing barriers to higher education in Chile: evaluation of peer effects and scholarships for test preparation, 3ie Impact Evaluation Report 36. Banerjee, A, Duflo E and Gallego, F, 2016.

Sustainability of impact: dimensions of decline and persistence in adopting a biofortified crop in Uganda, 3ie Impact Evaluation Report 35. McNiven, S, Gilligan, DO and Hotz, C 2016.

A triple win? The impact of Tanzania's Joint Forest Management programme on livelihoods, governance and forests, 3ie Impact Evaluation Report 34. Persha, L and Meshack, C, 2016.

The effect of conditional transfers on intimate partner violence: evidence from Northern Ecuador, 3ie Impact Evaluation Report 33. Hidrobo, M, Peterman, A and Heise, L, 2016.

The effect of transfers and preschool on children's cognitive development in Uganda, 3ie Impact Evaluation Report 32. Gillian, DO and Roy, S, 2016.

Can egovernance reduce capture of public programmes? Experimental evidence from India's employment guarantee, 3ie Impact Evaluation Report 31. Banerjee, A, Duflo, E, Imbert, C, Mathew, S and Pande, R, 2015.

Improving maternal and child health in India: evaluating demand and supply strategies, 3ie Impact Evaluation Report 30. Mohanan, M, Miller, G, Forgia, GL, Shekhar, S and Singh, K, 2016.

Smallholder access to weather securities in India: demand and impact on production decisions, 3ie Impact Evaluation Report 28. Ceballos, F, Manuel, I, Robles, M and Butler, A, 2015.

What happens once the intervention ends? The medium-term impacts of a cash transfer programme in Malawi, 3ie Impact Evaluation Report 27. Baird, S, Chirwa, E, McIntosh, C and Özler, B, 2015.

Validation of hearing screening procedures in Ecuadorian schools, 3ie Impact Evaluation Report 26. Muñoz, K, White, K, Callow-Heusser, C and Ortiz, E, 2015.

Assessing the impact of farmer field schools on fertilizer use in China, 3ie Impact Evaluation Report 25. Burger, N, Fu, M, Gu, K, Jia, X, Kumar, KB and Mingliang, G, 2015.

The SASA! study: a cluster randomised trial to assess the impact of a violence and HIV prevention programme in Kampala, Uganda, 3ie Impact Evaluation Report 24. Watts, C, Devries, K, Kiss, L, Abramsky, T, Kyegombe, N and Michau, L, 2014.

Enhancing food production and food security through improved inputs: an evaluation of Tanzania's National Agricultural Input Voucher Scheme with a focus on gender impacts, 3ie Impact Evaluation Report 23. Gine, X, Patel, S, Cuellar-Martinez, C, McCoy, S and Lauren, R, 2015.

A wide angle view of learning: evaluation of the CCE and LEP programmes in Haryana, 3ie Impact Evaluation Report 22. Duflo, E, Berry, J, Mukerji, S and Shotland, M, 2015.

Shelter from the storm: upgrading housing infrastructure in Latin American slums, 3ie Impact Evaluation Report 21. Galiani, S, Gertler, P, Cooper, R, Martinez, S, Ross, A and Undurraga, R, 2015.

Environmental and socioeconomic impacts of Mexico's payments for ecosystem services programme, 3ie Impact Evaluation Report 20. Alix-Garcia, J, Aronson, G, Radeloff, V, Ramirez-Reyes, C, Shapiro, E, Sims, K and Yañez-Pagans, P, 2015.

A randomised evaluation of the effects of an agricultural insurance programme on rural households' behaviour: evidence from China, 3ie Impact Evaluation Report 19. Cai, J, de Janvry, A and Sadoulet, E, 2014.

Impact of malaria control and enhanced literacy instruction on educational outcomes among school children in Kenya: a multi-sectoral, prospective, randomised evaluation, 3ie Impact Evaluation Report 18. Brooker, S and Halliday, K, 2015.

Assessing long-term impacts of conditional cash transfers on children and young adults in rural Nicaragua, 3ie Impact Evaluation Report 17. Barham, T, Macours, K, Maluccio, JA, Regalia, F, Aguilera, V and Moncada, ME, 2014.

The impact of mother literacy and participation programmes on child learning: evidence from a randomised evaluation in India, 3ie Impact Evaluation Report 16. Banerji, R, Berry, J and Shortland, M, 2014.

A youth wage subsidy experiment for South Africa, 3ie Impact Evaluation Report 15. Levinsohn, J, Rankin, N, Roberts, G and Schöer, V, 2014.

Providing collateral and improving product market access for smallholder farmers: a randomised evaluation of inventory credit in Sierra Leone, 3ie Impact Evaluation Report 14. Casaburi, L, Glennerster, R, Suri, T and Kamara, S, 2014.

Scaling up male circumcision service provision: results from a randomised evaluation in Malawi, 3ie Impact Evaluation Report 13. Thornton, R, Chinkhumba, J, Godlonton, S and Pierotti, R, 2014.

Targeting the poor: evidence from a field experiment in Indonesia, 3ie Impact Evaluation Report 12. Atlas, V, Banerjee, A, Hanna, R, Olken, B, Wai-poi, M and Purnamasari, R, 2014.

An impact evaluation of information disclosure on elected representatives' performance: evidence from rural and urban India, 3ie Impact Evaluation Report 11. Banerjee, A, Duflo, E, Imbert, C, Pande, R, Walton, M and Mahapatra, B, 2014.

Truth-telling by third-party audits and the response of polluting firms: Experimental evidence from India, 3ie Impact Evaluation Report 10. Duflo, E, Greenstone, M, Pande, R and Ryan, N, 2013.

No margin, no mission? Evaluating the role of incentives in the distribution of public goods in Zambia, 3ie Impact Evaluation Report 9. Ashraf, N, Bandiera, O and Jack, K, 2013.

Paying for performance in China's battle against anaemia, 3ie Impact Evaluation Report 8. Zhang, L, Rozelle, S and Shi, Y, 2013.

Social and economic impacts of Tuungane: final report on the effects of a community-driven reconstruction programme in the Democratic Republic of Congo, 3ie Impact Evaluation Report 7. Humphreys, M, Sanchez de la Sierra, R and van der Windt, P, 2013.

The impact of daycare on maternal labour supply and child development in Mexico, 3ie Impact Evaluation Report 6. Angeles, G, Gadsden, P, Galiani, S, Gertler, P, Herrera, A, Kariger, P and Seira, E, 2014.

Impact evaluation of the non-contributory social pension programme 70 y más in Mexico, 3ie Impact Evaluation Report 5. Rodríguez, A, Espinoza, B, Tamayo, K, Pereda, P, Góngora, V, Tagliaferro, G and Solís, M, 2014.

Does marginal cost pricing of electricity affect groundwater pumping behaviour of farmers? Evidence from India, 3ie Impact Evaluation Report 4. Meenakshi, JV, Banerji, A, Mukherji, A and Gupta, A, 2013.

The GoBifo project evaluation report: Assessing the impacts of community-driven development in Sierra Leone, 3ie Impact Evaluation Report 3. Casey, K, Glennerster, R and Miguel, E, 2013.

A rapid assessment randomised-controlled trial of improved cookstoves in rural Ghana, 3ie Impact Evaluation Report 2. Burwen, J and Levine, DI, 2012.

The promise of preschool in Africa: A randomised impact evaluation of early childhood development in rural Mozambique, 3ie Impact Evaluation Report 1. Martinez, S, Naudeau, S and Pereira, V, 2012.

In Malawi, more than 50 per cent of the population engaged in agriculture lives below the poverty line. Supporting and enhancing cost-effective agricultural extension systems is important in an economy centered around agriculture. Authors of this evaluation assess the impact of a programme that encourages farmers to adopt integrated soil fertility and management practices, by promoting the use of demonstration plots, farmer-based organisations and farmer field days.

Impact Evaluation Series

International Initiative for Impact Evaluation
202-203, Rectangle One
D-4, Saket District Centre
New Delhi – 110017
India

3ie@3ieimpact.org
Tel: +91 11 4989 4444

www.3ieimpact.org